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THE Petroleum Engineer

The Engineering Magazine of the Oil and Gas Industry

Edited and Circulated Only for those Actively Engaged in the Operating Departments of the Industry

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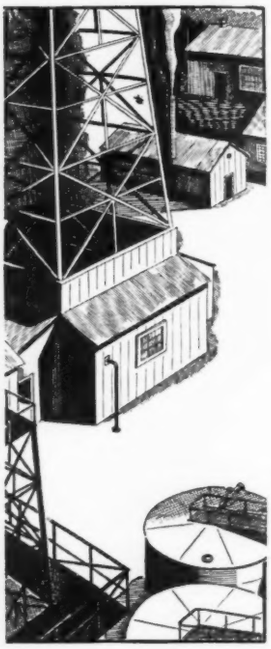

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The Month's HIGH LIGHTS in OILDOM

By J. L. DWYER

AFTER running for many moons in the red ink, the petroleum industry at present is believed to be operating on a profitable basis. The majority of companies indicate that their current industrial position shows them to be realizing an operating profit, and unless some unforeseen circumstances are experienced, the remainder of this year may observe the present trend for the industry.

Statistically, the position of the industry is far better than that of any vast business comparable to oil. The market for petroleum and its products has retained a rate of consumption which might well cause other industries to look with envy on our field. While present studies of the consumption of petroleum and its products for the remainder of the year influence the belief that a decrease of 10 or 15 per cent will be experienced, there is many an industry in the land today which has for its market a consumption rate 50 or 60 per cent less than last year.

During the first part of June, 1932, the wholesale gasoline market touched five cents and better, a price which had not been yielded to the refiner for 15 or 16 months. This lends another note of encouragement to the situation.

The Oklahoma oil curtailment act was sustained as valid by the United States Supreme Court last month in a case brought by the Chaplin Refining Company of Enid, Okla.

The opinion delivered stated that the regulations and pool rationing orders of the Oklahoma corporation commission, issued under the curtailment act, were valid.

The court, however, set aside as invalid, section nine of the act, which would enable the state to proceed against violators of the conservation laws to have their oil properties placed in the hands of receivers.

The court also refused to rule on the validity of section eight, saying this was not properly before it.

Justice Butler said that the commission, which issued the order for the curtailment of production, permitted full marketable production of each pool and had not attempted to fix prices.

The decision will not prevent oil producers from applying to the courts for injunctions for relief, should orders of the commission be unwarranted by conditions in the future.

The decision further states that the production of oil was a mining operation and was not in itself interstate commerce, therefore the curtailment orders did not constitute a burden on interstate commerce.

That the forces of oil all over the world are showing some inclination to get together and adjust their differences is indicated by the recent conference in New York, where representatives of British, American, and Russian oil groups met in an effort to regulate the world production of petroleum, and to restrict the markets for petroleum products. While the meeting adjourned with no definite agreement, it is believed that much progress was made which may ultimately result in many benefits to the industry.

During the past month, the number of completed wells in the East Texas field passed the 6,000 mark. East Texas certainly has established many novel records.

The new Conroe field northeast of Houston is looking up in importance, and the most interesting development regarding it is the fact that some evidences of structure have been found. For a while it was feared that it might result in another East Texas, and the structural features have done much to allay this fear.

Production and Refining Figures Furnished by the American Petroleum Institute

Crude Runs to Stills, Gasoline and Gas and Fuel Oil Stocks, Week Ending June 4, 1932

(Figures in Barrels of 42 gallons each)

DISTRICT	Per Cent Potential Capacity Reporting	Daily Avg. Crude Runs to Stills	Per Cent Operated of Total Capacity Reporting	Gasoline Stocks	Gas and Fuel Oil Stocks
East Coast	100.0	474,600	74.9	6,634,000	6,492,000
Appalachian	91.8	94,900	69.1	1,755,000	1,032,000
Ind., Ill., Ky.	98.9	228,100	66.8	6,358,000	4,050,000
Okla., Kans., Mo.	89.6	222,300	51.1	3,878,000	3,221,000
Texas	91.3	558,400	73.0	7,797,000	9,843,000
Louisiana-Arkansas	98.9	156,700	68.0	1,825,000	4,679,000
Rocky Mountain	89.4	28,300	19.7	2,001,000	639,000
California	96.7	437,700	49.5	13,997,000	97,102,000
Total Wk. June 4	95.1	2,261,000	61.7	44,247,000	*127,058,000
Total Wk. May 28	95.1	2,319,300	63.3	44,337,000	126,660,000
Total June 6, 1931	94.7	2,418,400	66.3	‡43,541,000	130,508,000
The Texas and Louisiana Gulf Coast figures shown below are included above in the totals of their respective districts					
Texas Gulf Coast	99.8	446,400	84.0	6,229,000	6,885,000
La. Gulf Coast	100.0	101,100	68.5	1,625,000	3,954,000

Daily Average Production

(Figures in Barrels)

	June 4, 1932	May 28, 1932	June 6, 1931
Oklahoma	408,000	399,150	552,400
Kansas	95,950	86,900	107,000
Panhandle Texas	54,450	51,550	59,900
North Texas	50,000	51,550	55,750
West Central Texas	24,050	25,450	25,850
West Texas	184,800	183,900	209,000
East Central Texas	56,800	56,900	56,750
East Texas	349,950	334,300	351,500
Southwest Texas	54,950	54,600	58,800
North Louisiana	29,100	29,250	37,750
Arkansas	34,050	34,300	45,700
Coastal Texas	114,300	113,650	149,750
Coastal Louisiana	34,700	33,900	28,950
Eastern (not including Mich.)	108,500	108,250	101,500
Michigan	19,100	19,200	8,150
Wyoming	37,900	38,200	42,050
Montana	7,550	8,650	8,100
Colorado	3,150	3,300	4,050
New Mexico	35,950	36,700	42,900
California	478,000	489,700	529,100
Total	2,181,250	2,169,400	2,474,950

NOTE: Stocks at refineries, except in California district, which includes stocks of finished gasoline and engine distillate at refineries, water terminals and sales distributing stations and amounts in transit thereto.

‡This figure is not entirely comparable with current stocks due to revisions made since original publication of this figure, for which revisions the basic information is not available by weeks. If it were possible to have made the revision, the new figure would reflect somewhat lower stocks.

*Not comparable with previous week's figure due to transfer in Oklahoma-Kansas district of 108,000 barrels from gas and fuel oil storage to charging stock for cracking plants.

Stored Indian Oil Subject to Ad Valorem Taxes

Oil produced from Indian lands in one county and stored in another is subject to ad valorem taxes, according to an opinion handed down by Justice Andrews in the state supreme court. The opinions reversed decisions of district judges in Tulsa and Payne counties.

Seaboard Revives Cash Dividend

The Seaboard Oil Company, originally known as the Mexican Seaboard Oil Company, which paid its last dividend in November, 1924, ordered a quarterly payment of 10 cents on its stock, payable June 15th, to stock of record June 6th. A few weeks previously, the Ohio Oil Company authorized a payment of 20 cents after being out of the dividend column for more than a year.

Consolidated Making a Profit

According to Harry F. Sinclair, chairman of the executive committee, the Consolidated Oil Corporation is now operating at a profit. The company represents the consolidated unit, growing out of the merger of the Sinclair Oil Corporation, Prairie Oil and Gas Company and Prairie Pipe Line Company.

Renewed Activity in Northeastern Colorado

The northeastern district of Colorado is commanding new interest and consideration from oil men with half a dozen new tests under way. The Greasewood area is showing the most operations with two new tests assured, these being north and east of the producing area.

A number of scattered rigs complete the activity.

Gasoline Tax Brings Orders to Refiners

Brokers and marketers were flooding refiners with orders recently, prompted by the enactment of the one-cent a gallon Federal gasoline tax. They were hoping to obtain delivery and storage capacity before the levy becomes effective June 21.

As a result of the temporarily increased buying, wholesale prices were high, with natural gasoline also showing strength.

Intelligent Control of Production Is Essential.—Farish

Low cost production, with corresponding low prices of products and a stabilized producing enterprise, such as results from intelligent control of production, is essential to the welfare of the oil industry and as well to the American people, W. S. Farish of Houston, president of the Humble Oil and Refining Company, told business men of the nation assembled in the twentieth annual meeting of the United States Chamber of Commerce in California recently. That form of control has shown its benefits in other oil producing nations because oil fields are generally held in large ownerships and producers are free to enter agreements to control production, he said.

In answer to condemnation of "control of production" and the often cited failures in attempts to control production of such materials as coffee, copper and rubber, Mr. Farish asserted his confidence that control of production of oil is not only justifiable and necessary but that failure to exercise control amounts to an economic and social crime. New crops of coffee and rubber are continuously being grown and proved copper reserves are adequate to meet the needs of the next 75 or 100 years, whereas crude oil is an "essential, irreplaceable commodity, the known reserves of which are limited and modest in proportion to current needs."

Conroe Field Becomes Latest Outstanding Strike

The completion of the fourth well in the new Conroe field, 40 miles northeast of Houston, Texas, has given the area all the earmarks of an important oil field. The oil produced in the field tests 40 degrees A. P. I., and is produced from a depth averaging 5,100 feet.

East Texas Proration Hearing Scheduled for June 21

The Railroad Commission has fixed June 21 as the next hearing on proration rules for East Texas. The present order expires June 30 and to prevent a hiatus in control a new order will be adopted in advance of July 1st to become effective on that date.

Because of the constantly lowering well allowable under the expiring order which set 325,000 barrels as the allowable for the field, it is probable that a determined effort will be made to raise the maximum to a figure above the present one. There are now more than 6,000 wells in the field and the per well allowable to keep the field's output to 325,000 barrels daily will have to be lowered to 50 barrels per well.

Crude Oil Is Taxed 100 Per Cent

The average gasoline tax now imposed by the various states of the Union exceeds 4 cents per gallon. The average price of gasoline received by the refiner has been approximately 4 cents per gallon. Therefore, the tax was 100 per cent of the wholesale price prior to the passing of the new Federal bill, which adds another 1 cent tax to the gasoline tax of the states.

The average price of crude oil at the well during 1931 was 67 cents per barrel. The gasoline tax in 1931 was $549,150,000, which is equal to 64½ cents per barrel on the entire crude oil production of the United States, or 97 per cent of the gross value of the crude oil.

At the present time the average crude oil price is somewhere around 86 cents for the Mid-Continent area, or equivalent to 2 cents per gallon at the well. While federal tax, plus the state tax on gasoline, will average around 5 cents per gallon. Thus it will be seen that in the Mid-Continent the raw product is taxed approximately 200 per cent, or figuring on the basis of the manufactured product it is slightly in exces of 100 per cent.

Hobbs Pool Extended by Large Well

The Hobbs pool, Southeastern New Mexico, was extended approximately half a mile north by Amerada Petroleum Corporation's Hardin No. 1, which came in for an estimated initial flow of 10,000 barrels daily.

Headed for a Balance Between Potential Supply and Demand.—Beaty

Amos L. Beaty, president of the American Petroleum Institutes, in an article written for the *Quarterly*, publication of the Institute, states:

"There has been a corresponding decline in drilling operations, and they are still at a low. Very little wildcatting is being done. Proven areas are being drilled for the purpose of increasing participation in allowables. Probably two-thirds of this drilling is in the East Texas area, where allowed production is based upon the number of wells. Wildcatters cannot finance their operations as they could a few years ago. Money lenders and get-rich-quick investors are hard to find. Low prices for crude, coupled with the fact that if new pools are brought in they will be under proration rather than on the old gusher basis, have worked a vital change in this kind of enterprise. Even the major companies have given up their wild scramble for acreage. In the aggregate they have surrendered many million acres of prospective oil land held under lease rather than pay rentals. Thousands of stripper wells, which a few years ago were considered the backbone of the industry, have been abandoned and put out of the picture. So that, as a long-pull proposition, we are definitely headed for a balance between potential supply and demand."

Writ in Oil Proration Fight Denied

The troublesome question of how Oklahoma's proration of oil production is to be enforced was returned to the State Corporation Commission June 9th, the State Supreme Court denying the H. F. Wilcox Oil and Gas Company an alternative writ of prohibition to halt enforcement of the oil curb against the concern.

To Collect Alleged Gross Production Taxes

Governor Murray of Oklahoma has issued an executive order naming A. S. Wells of Wewoka as special attorney to bring suits in state and federal courts to collect alleged delinquent gross production taxes on the three per cent production that oil producers are allowed to deduct for waste in computing their taxes.

Every state auditor since the gross production tax law was enacted and members of the Murray-appointed tax commission have been making the gross production tax on the basis of 97 per cent of the crude and not 100 per cent.

Gasoline Tax Application Hearing

A hearing was held before the Collector of Internal Revenue, at Washington, D. C., on June 9th, for the purpose of interpreting the application of the new federal excise tax imposing one cent a gallon on gasoline, as well as to effect regulations by the Commission for its application and collection.

Knowing that products from natural gasoline plants move in channels peculiar to the natural gasoline industry, Ray E. Miller, secretary of the Natural Gasoline Association of America, requested Fayette B. Dow to represent the Association at the hearing.

Bill Requires Liquid Fuel Shippers to Report Cargoes

Under a bill introduced in the United States Senate by Senator David A. Reed, of Pennsylvania, consignors of liquid fuels would be required to make monthly reports to the U. S. Bureau of Mines on all shipments of liquid fuels across state lines. The measure, which was referred to the Committee on Interstate Commerce, apparently is designed to combat the bootlegging of gasoline and other motor fuels across state lines for the purposes of state tax evasion. The Bureau of Mines would be required to assemble the statistical information and make the record available to the taxing authorities of the states.

Law for Ratable Taking of Gas Held Unconstitutional

That the last Texas Legislature exceeded its power in adopting a common purchaser act applying to all gas pipe lines was the decision of a three-judge Federal Court sitting in Austin. The act would have compelled gas pipe line companies to buy gas ratably so that all land owners could sell their products instead of having it drained from beneath their land through the leases having connections.

The opinion holds that the plaintiffs are private carriers of gas, engaged solely in the business of producing gas from their own leases and transporting it through their own pipe lines to consumers in other states.

East Texas Allowable Reduced

A new per well allowable went into effect in East Texas on June 1st. The new figure is 54 barrels per well, a reduction of five barrels from the previous allowable outlet.

According to Jack Pew, chairman of the East Texas pipe line committee, the saturation point as far as pipe line companies taking on new connections is concerned is very near. On the first of June there were between 70 and 75 wells in the area without pipe line connections, but the new allowable, effective on that date, was expected to provide room for these wells to flow their output.

Sinclair Bids for Richfield Oil Company

Through the Consolidated Oil Corporation, holding concern for the recently merged Sinclair-Prairie companies, Harry F. Sinclair has presented a tentative proposal for the acquisition of the Richfield Oil Company of California. The Richfield properties and holdings have been carefully surveyed by Sinclair interests and his tentative proposal to the three committee groups directly interested in the disposal of Richfield was not a surprise.

It is understood that Sinclair's proposal is the third one to be received from various concerns for the property of the Richfield Company, which for a number of years has been a large factor in the California markets.

Latest Activities in th

Figures on maps indicate average prices paid for oil in adjacent fields

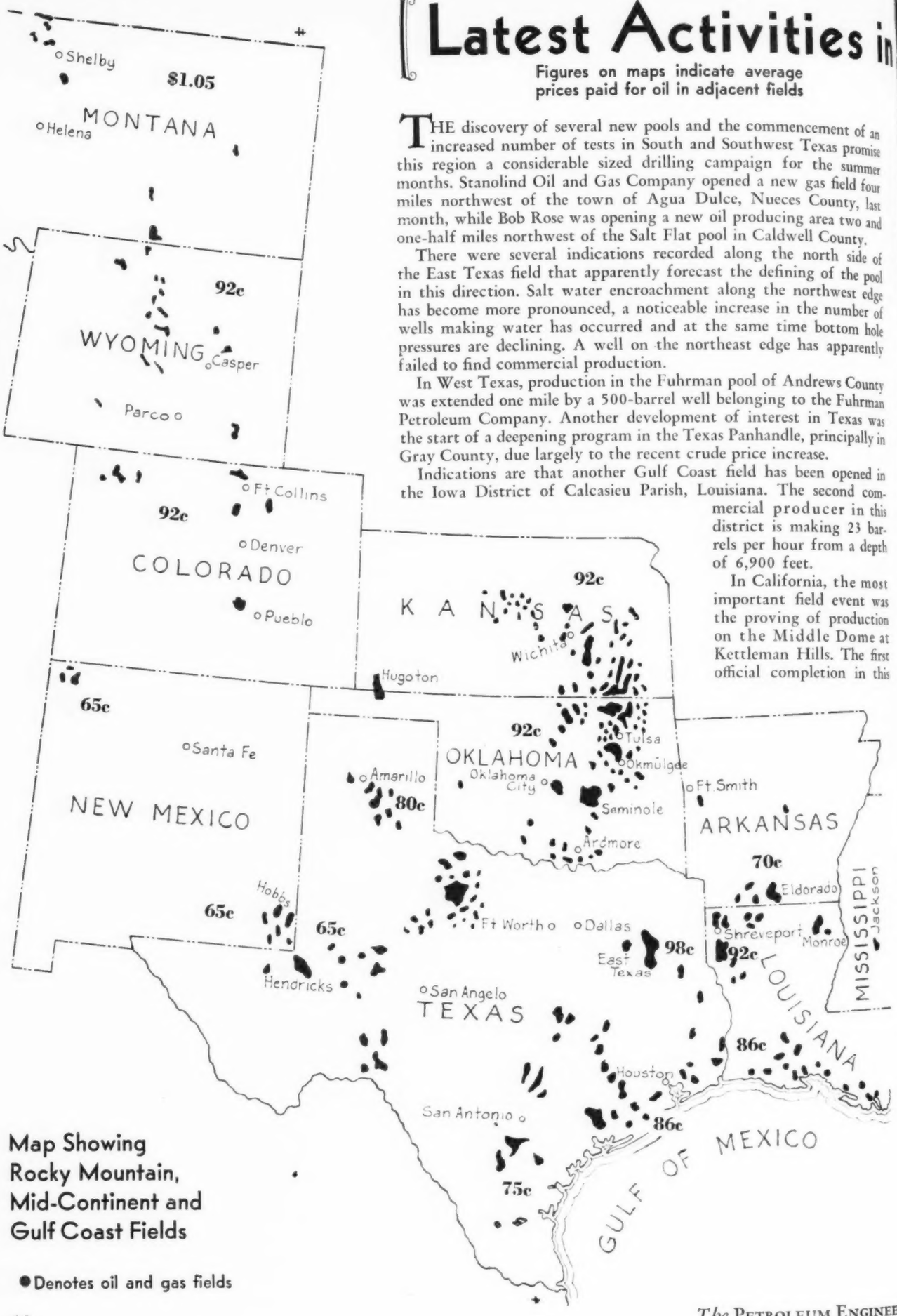
THE discovery of several new pools and the commencement of an increased number of tests in South and Southwest Texas promise this region a considerable sized drilling campaign for the summer months. Stanolind Oil and Gas Company opened a new gas field four miles northwest of the town of Agua Dulce, Nueces County, last month, while Bob Rose was opening a new oil producing area two and one-half miles northwest of the Salt Flat pool in Caldwell County.

There were several indications recorded along the north side of the East Texas field that apparently forecast the defining of the pool in this direction. Salt water encroachment along the northwest edge has become more pronounced, a noticeable increase in the number of wells making water has occurred and at the same time bottom hole pressures are declining. A well on the northeast edge has apparently failed to find commercial production.

In West Texas, production in the Fuhrman pool of Andrews County was extended one mile by a 500-barrel well belonging to the Fuhrman Petroleum Company. Another development of interest in Texas was the start of a deepening program in the Texas Panhandle, principally in Gray County, due largely to the recent crude price increase.

Indications are that another Gulf Coast field has been opened in the Iowa District of Calcasieu Parish, Louisiana. The second commercial producer in this district is making 23 barrels per hour from a depth of 6,900 feet.

In California, the most important field event was the proving of production on the Middle Dome at Kettleman Hills. The first official completion in this



Map Showing Rocky Mountain, Mid-Continent and Gulf Coast Fields

● Denotes oil and gas fields

the Oil Fields

Figures giving production of individual fields will be found on page 9

area, a well of Standard Oil Company, made 1,250 barrels of 53 gravity oil and 40,000,000 cubic feet of gas and has not been completely drilled into the producing horizon. A decided pick-up in drilling permits was also registered by the state, including the starting of several wildcats.

The most interesting area in Kansas is the Ellsworth Arch district, a region spreading over 70 miles in length, in which are many one-well pools. Several promising showings during the past month indicated that additional new areas may be found productive. It is likely, however, that any intensive drilling campaign will await better drilling prices.

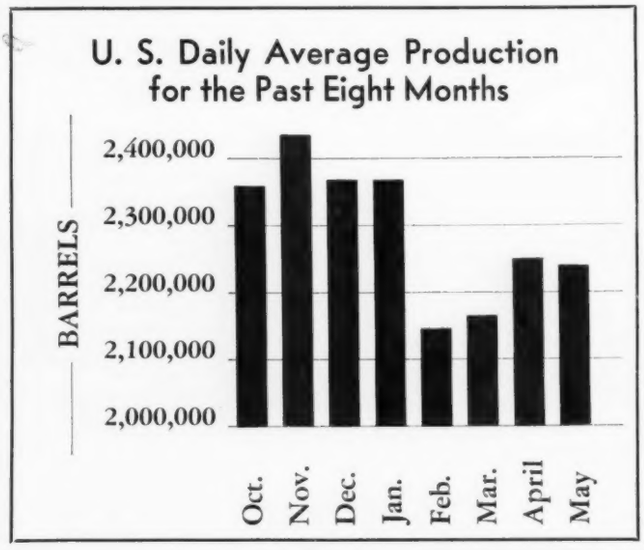
Activity in Oklahoma continues to slowly increase, but there is little concentrated activity outside of Oklahoma City and the area south of the Greater Seminole district. A new field, known as West Konawa, was opened by the Gypsy Oil Company, et al, five miles south of the town of Konawa. The well was making 55 barrels an hour when shut in.

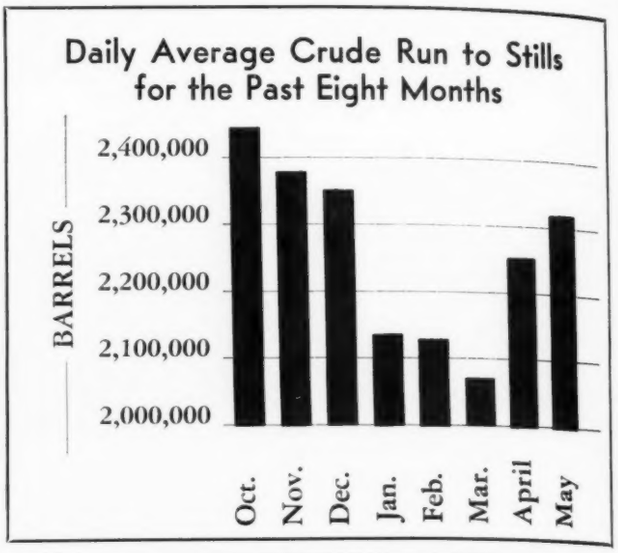
In the Eastern fields the principal developments have been increased activity in southeast Washington County, Ohio. The spurt in operations has been stimulated by new completions. There are also prospects of considerable wildcatting in several areas of Michigan. The largest producer since curtailment went into effect in West Virginia was finished in May with an initial flow of 135 barrels daily. The well is in the Sherman area of Calhoun county.

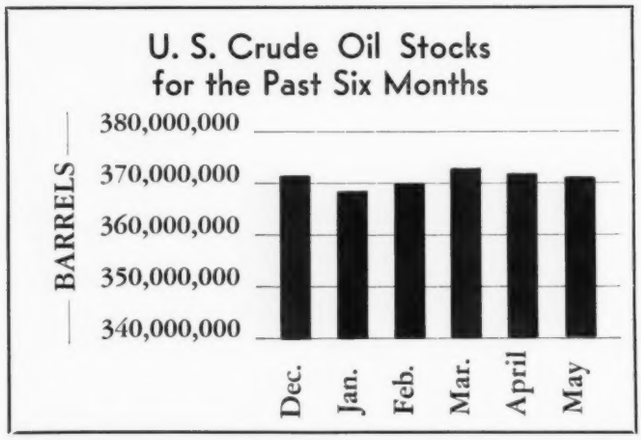
The Jackson, Mississippi, gas field was extended in two directions last month. A new commercial well carried the producing limits one-quarter of a mile southeast while another test was finished a half mile ahead of production to the northwest.

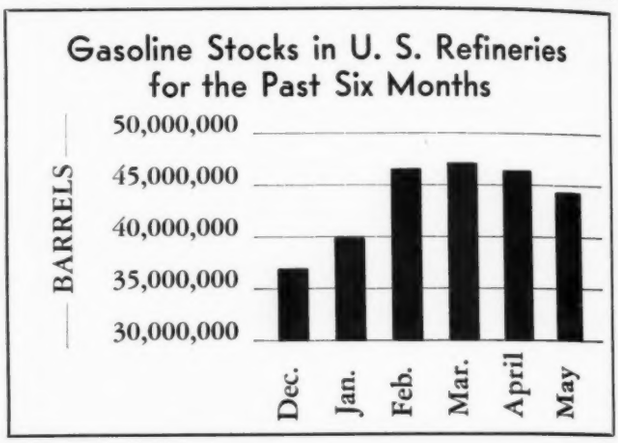
California Fields

East Central and Eastern Fields







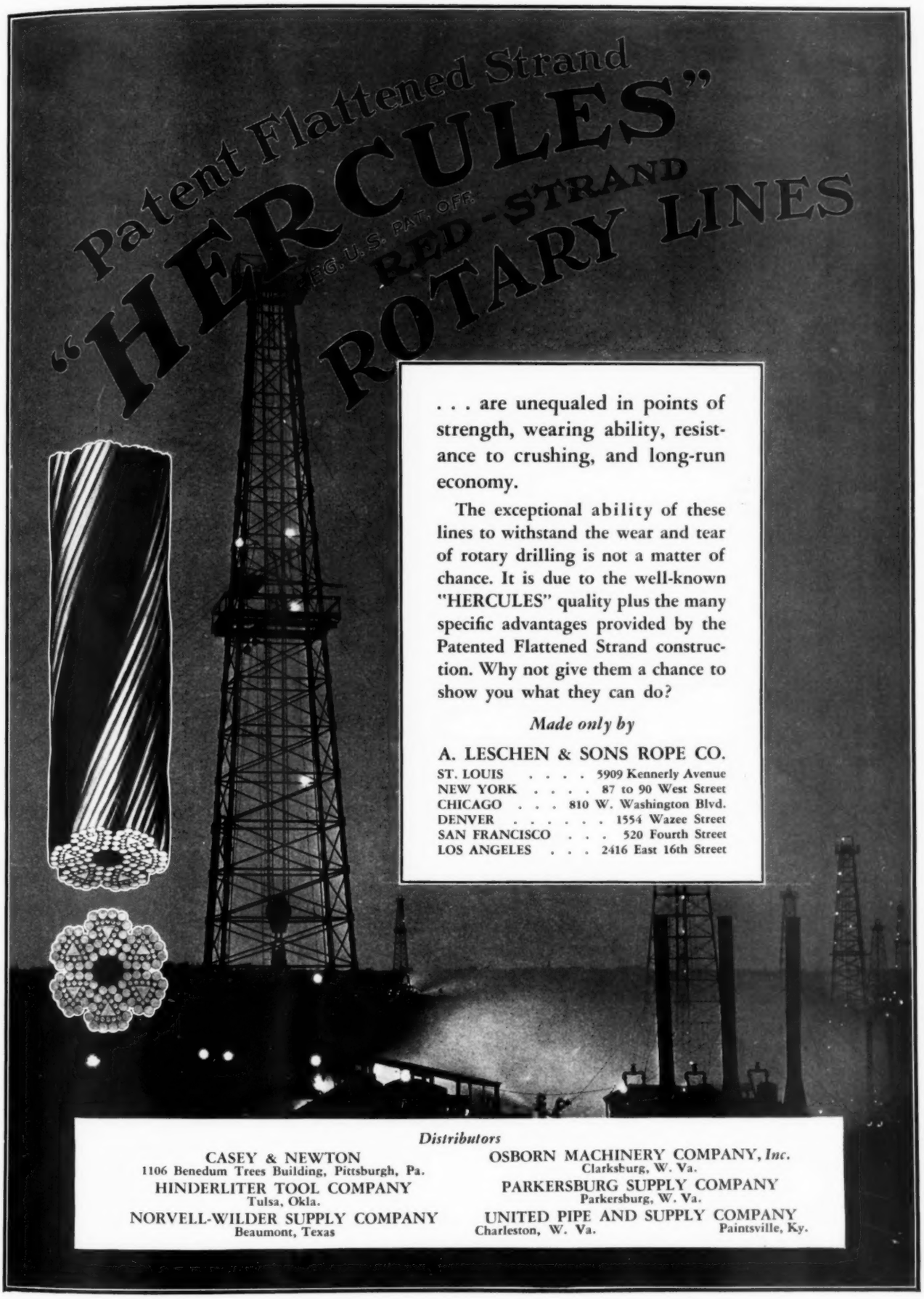


Summarized Operations in Active Fields for May, 1932

Fields	Completions	Producers	Locations	Rigs	Drilling Wells	Depth of Production	Gravity of Oil	Type of Tool Used
Texas								
East Texas	550	545	700	188	568	3600	40	Rotary
Van	8	7	12	3	13	2600	36	Rotary
Panhandle	10	9	13	11	45	2900	40	Rotary
Oklahoma								
Oklahoma City	15	15	19	5	74	6500	39	Rotary
Kansas								
McPherson	6	5	17	10	36	2900-3400	38	Rot.-Cab.
Ellsworth Arch	5	5	10	5	21	3300	37	Cable
Sedgwich	2	0	7	4	12	2900-3500	39	Rot.-Cab.
California								
Kettleman Hills	2	2	2	1	14	8300	60	Rotary
Long Beach	1	10	4	3	21	7000	26	Rotary
Ventura	2	2	3	1	10	7800	36	Rotary

Field Activities by States for May, 1932

State	Completions	Producers	Locations	Rigs	Drilling Wells	Production, 1931 (in Barrels)
Arkansas	5	0	1	8	28	15,425,000
California	21	20	60	31	182	188,575,000
Colorado	1	0	2	10	65	1,510,000
Illinois	3	0	....	2	19	4,850,000
Indiana	10	4	....	5	58	830,000
Kansas	25	19	61	37	105	37,950,000
Kentucky	46	33	....	9	65	6,490,000
Louisiana	24	13	54	27	89	22,325,000
Michigan	14	11	....	6	82	3,730,000
Mississippi	2	1	....	5	14	Gas Prod.
Montana	2	1	2	13	49	2,855,000
New Mexico	4	3	....	7	40	15,250,000
New York	11	11	....	2	21	3,400,000
Ohio	45	34	....	31	105	5,315,000
Oklahoma	74	53	92	89	213	177,750,000
Pennsylvania	47	40	....	22	81	11,225,000
Tennessee	1	0	....	0	16	8,000
Texas	809	691	1,042	503	955	330,720,000
West Virginia	17	12	....	19	39	4,480,000
Wyoming	2	2	....	11	61	14,725,000
Total	1,163	948	1,314	837	2,287	



. . . are unequaled in points of strength, wearing ability, resistance to crushing, and long-run economy.

The exceptional ability of these lines to withstand the wear and tear of rotary drilling is not a matter of chance. It is due to the well-known "HERCULES" quality plus the many specific advantages provided by the Patented Flattened Strand construction. Why not give them a chance to show you what they can do?

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Progress of Major Pipe Line Work

By J. H. DAMERON

SOUTHERN COUNTIES GAS CO. has started construction work on its 12-inch welded line in Southern California, which, when completed, will serve San Diego with natural gas. The contract for construction was awarded to Lindgren & Swinerton, Los Angeles and San Francisco general contractors. The entire line is to be electric welded and sub-contract for welding was awarded to H. C. Price, Inc., Bartlesville, Okla.

The new line originates near Long Beach, where it intersects the Southern Counties Company's existing main transmission system. The cost of the project is in excess of $1,000,000, and the project is scheduled for completion late in the summer.

Construction work on the Southern Counties line constitutes the only major pipe line work in progress at the present time. Two smaller projects in oil line work are under way in the Mid-Continent. The White Eagle Company in Kansas is building a short line and in Texas the Texas Pipe Line Company has a small project 50 per cent complete. This involves taking up some old lines, reconditioning the pipe and building a short line in East Texas area. The work is expected to be completed within the next 30 to 40 days.

The only other oil line work of major importance looming on the horizon at present is the proposed line of the Standard Oil Company of Kansas. The Standard Company plans the construction this summer of approximately 150 miles of welded eight-inch line running into the newer pools of Western Kansas. No definite announcement has been made relative to the starting of construction.

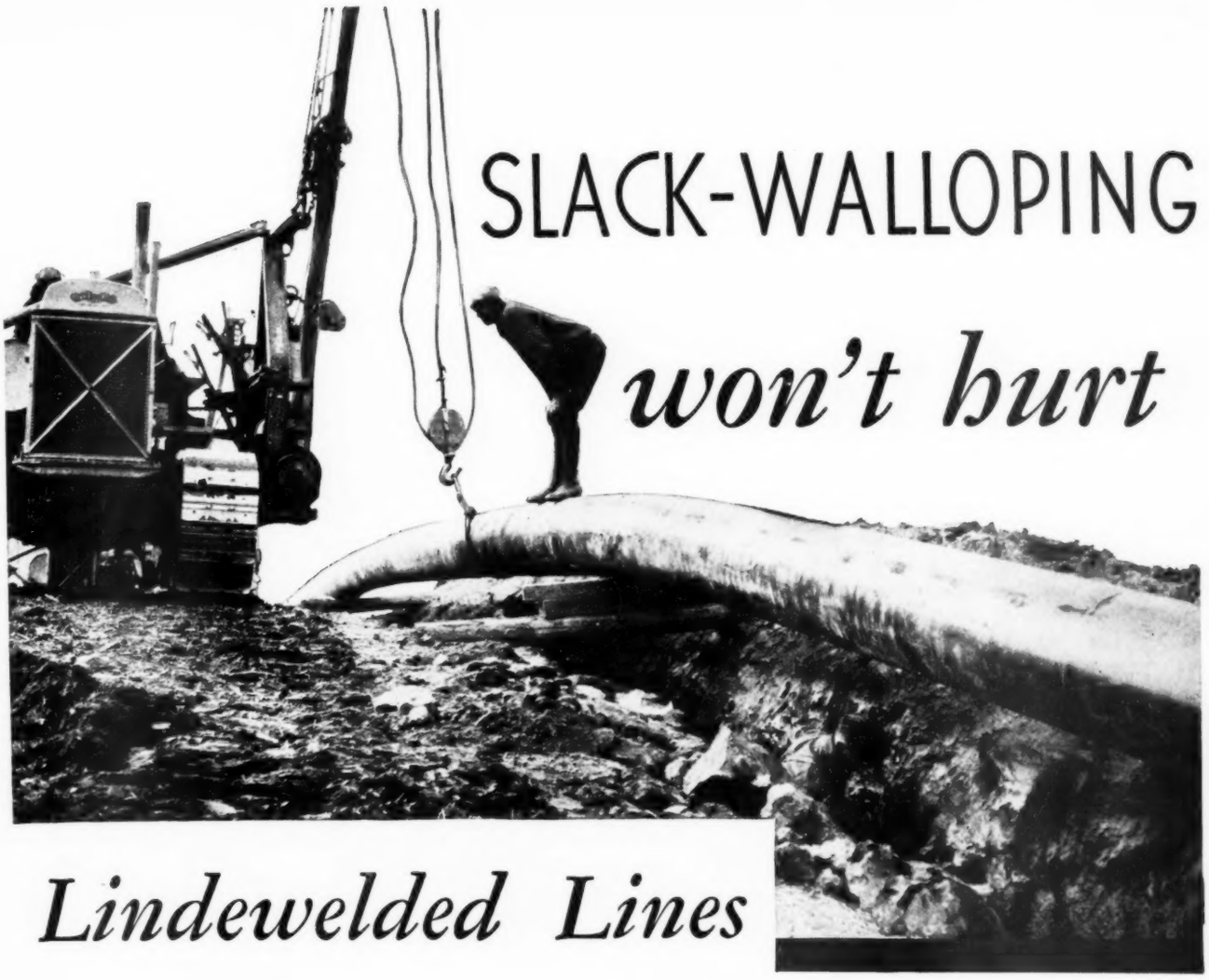
Numerous oil companies are engaged in considerable repair work to old lines and the annual general overhauling of pumping equipment. Some of the reconditioning work to old lines in the Mid-Continent will spread over the summer months and in the East many similar jobs are under way which will require several months' time. For the most part this work consists of raising the old lines, spot welding pit holes or half-soling the pipe, painting it in spots and lowering it back in the trench.

Some of the natural gas transporting companies are engaged in the construction of short lateral lines. Panhandle Eastern Pipe Line Company made an early start on this type of work and is nearing completion of the work scheduled for 1932. Several of the companies operating in the North and Northwest are pushing construction of their new lateral line work and in some instances additional compressor capacity is being added.

Some of the proposed projects originating or planned for that area appear to have better chances of being built. Cities in that general territory are more anxious to be served by natural gas systems and in some instances where delays have hampered plans the cities have granted extensions of time to the promoters for the fulfillment of franchise requirements. Several promoters, backed by power companies, are making strong bids to obtain franchises in the larger cities and obtaining the franchises of all the smaller cities and towns along the proposed routes of new lines.

Plans for the construction of additional gasoline lines are occasionally rumored. One of the Mid-Continent's gasoline transporters has completed additional station capacity on its system and the other may start construction work on booster stations for its system within the next 30 to 60 days. The latter company may build boosters of a type radically different from the type of stations heretofore built for that work.

A group of refiners in the Wichita Falls, Texas, district are reported considering the construction of a gasoline line originating in that area and terminating at the loading rack at a point in Southern Oklahoma. The purpose of the proposal is to afford the Wichita Falls refiners a better freight rate position for marketing. The refiners could pump gasoline northward a short distance to obtain a lower freight rate on northern shipments. In order to reduce distribution costs several companies are reported considering the building of several short small diameter lines from refineries or bulk stations to rich markets. This practice has witnessed a small but steady growth during the past year and many companies have found it a profitable method of reducing distribution costs.



SLACK-WALLOPING *won't hurt* *Lindewelded Lines*

A TEXAS pipe line company subjected a 2,000-ft. test section of 24-in. Lindewelded line to severe bending strains by "slack-walloping" it on skids over a 64-in. trench. The line was allowed to expand and contract with changing temperatures. Not a joint failed. Lindewelding insures strength.

It saves money, too.

Lindewelding takes 30 to 60 per cent. less time than other methods and requires 30 to 40 per cent. less welding material. It is not a new kind of welding; it is a new way to do oxy-acetylene welding. It can be done with ordinary blowpipes or with special apparatus which makes welding almost automatic and further increases its speed. Experienced welders quickly master Lindewelding technique; beginners learn it more readily than other methods.

Procedure controls for this cost-cutting method of oxy-acetylene welding are available to all Linde customers as a part of Linde Process Service. Any Linde District Office will be glad to give you complete information.

Motion Picture Shows details of Lindewelding

Lindewelding technique differs from neutral-flame welding technique in that it employs a special rod, a special flame adjustment, and the "backhand" method of blowpipe manipulation. The actual steps in making a Lindewelded joint are shown in our motion picture, "The Lindeweld Process for Pipe Line Construction". This picture will be loaned free of charge to pipe line officials and welding or engineering societies. It is furnished in 16 mm. and 35 mm. safety film and can be obtained by writing to any Linde District Office.

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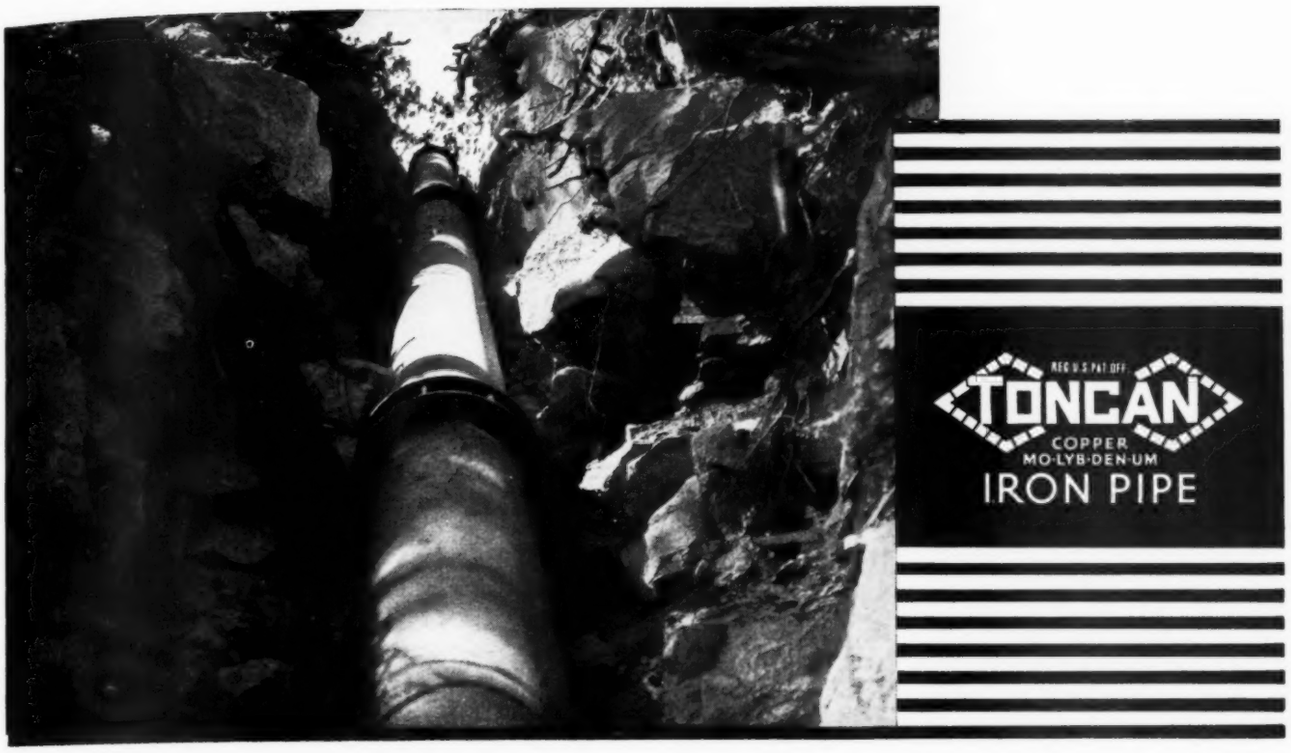
PIPE LINES UNDER CONSTRUCTION AND CONTEMPLATED

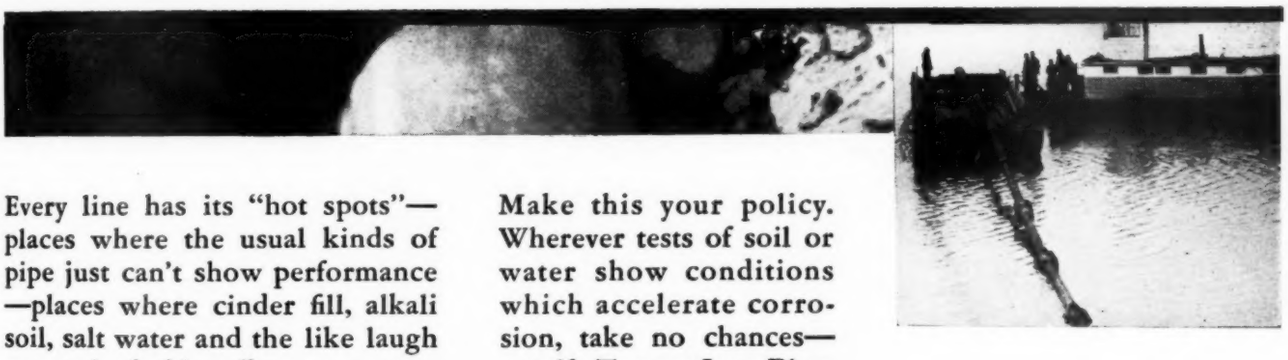
Type Line	Company Name	Headquarters	Point of Origin	Terminal	Size Pipe	Length in Miles	Remarks
Ga.L.	Atlantic Refg. Co.	Philadelphia, Pa.	Point Breeze	Wilkes-Barre, Pittsburgh	6-8"	475	Part of system operating. Plan extension of main line this year.
G. L.	Bivens, C. E., et al.	Laramie, Wyo.	Baggs Field	Laramie, Wyo.	12"	104	Plan to build in 1932. Granted extension of time.
G. L.	Big Bend Pipe Line Co.	Ft. Stockton, Tex.	(See Remarks)				Plan to extend present system with 60 miles of 4-inch.
G. L.	Columbia Gas & Elec. Co.	New York, N. Y.	Ky. or Pan Eastern Line	Detroit, Mich.	20"	220	Considering going to Detroit, Mich., with line and to Toledo.
G. L.	Continental Constr. Corp.	Chicago, Ill.	Chicago, Ill.	Detroit, Mich.	20"	200	Plan extension of Panhandle line to Detroit.
G. L.	Continental Constr. Corp.	Chicago, Ill.	Point in Ill.	Wilwaukee, Wis.	20"	160	Under advisement.
G. L.	Cities Service, Insull, Texas Corp. & S. O. N. J.	(See Remarks)					Rumored considering building 1,500-mile project from Panhandle to Eastern cities.
G. L.	Golston, Roy D.	Tyler, Tex.	Brownwood, Tex.	Lampasas, Tex.			Considering building gas line.
Ga.L.	Great Lake Pipe Line Co.	Kansas City, Mo.	Okla. Midcontinent	Great Lakes Region	4-6-8"	1440	Considering increasing station capacity.
G. L.	Great Northern Gas & Utilities Co.	Minneapolis, Minn.	(See Remarks)				Planning gas line from Baker-Glendive area in Montana to Minneapolis and St. Paul.
G. L.	Hutcherson Pipe Line & Gas Co.	McPherson, Kan.	(See Remarks)				To build short line from Ritz-Canton area in McPherson County, Kan., to McPherson.
G. L.	International Util. Corp.	New York, N. Y.	Alberta, Canada	Vancouver, B. C.	20"	500	Proposed
G. L.	Kentucky Public Service Co.	(See Remarks)					Posted bond to build short line from Hart County, Ky., to Bardstown, Ky.
G. L.	Jerome Drumheller	Spokane, Wash.	Cut Bank, Wyo.	Seattle, Wash.	20"	500	Proposed.
G. L.	Lycoming Nat. Gas. Corp.	New York, N. Y.	Tioga Field, N. Y.	Syracuse, N. Y.			Plan to extend main line from Syracuse to Oswego with 38 miles of 16-inch.
G. L.	Lewiston Nat. Gas Co.	Lewiston, Mont.	Armells Structure, Mont.	Montana Towns	4-6"	100	Proposed.
G. L.	Mid-Continent Public Service Co.	Fort Scott, Kan.	Field near Chanute	Fort Scott	8"	28	Moore-Creekmore Const. Co., Tulsa, have contract to build upon completion of plans.
G. L.	Missouri Valley P. L. Co.	Omaha, Neb.	Point in Minnesota	Minneapolis, Minn.	16"		Proposed along with extension work in Iowa.
G. L.	Montana-Dakota Power Co.	Minneapolis, Minn.	Williams, N. D.	Minot, N. D.	12"	100	Applied to N. D. Commission for permission to build.
G. L.	Mo.-Kans. Pipe Line Co.	Chicago, Ill.	Russellville, Ky.	Nashville, Tenn.	10"	50	Proposed.
G. L.	North Central Gas Co.	Casper, Wyo.	(See Remarks)				Reported planning 100 miles of extension work in Nebraska and near-by territory.
O. L.	Old Dutch Refining Co.	Muskegon, Mich.	East Michigan Fields	Muskegon	4"	100	Considering building.
G. L.	Ohio Oil Company	Findlay, Ohio	Weiser Field, Idaho	Boise and Northwest Area			Filed application for conveyance certificate.
G. L.	Pacific Gas & Elec. Co.	San Francisco, Calif.					Have appro. for $2,000,000 expansion campaign. Building 45 miles of 26-inch.
G. L.	Panhandle Eastern P. L. Co.	Kansas City, Mo.	(See Remarks)				Completing lateral line work.
O. L.	Presidio Petroleum Co., Ltd.	Los Angeles, Calif.	Midland, Tex.	Topolobampo	10"	640	Propose to build to Mexican Port and erect two refineries, one at Chihuahua for domestic trade and the other at tidewater for export trade. Plan to parallel oil line with gas line to Chihuahua. J. F. Sadler promoting.
O. L.	San Juan Pipe Line Co.	Los Angeles, Calif.	San Juan County, Utah	Farmington, N. M.	8"	92	Reported planning to build this summer. Line will have three stations.
Ga.L.	Sun Pipe Line Company	Philadelphia, Pa.	Point in N. Y.	Lake Ontario	6"	45	Extending to tidewater terminal.
G. L.	Southern California Gas Co.	Los Angeles, Calif.	(See Remarks)				Building laterals to three new towns.
G. L.	Southern Counties Gas Co.	Los Angeles, Calif.	Huntington Beach	La Jolla	12"	68	To supply gas to San Diego. Construction to start June 1. Line will be welded.
G. L.	Southern Nat. Gas Corp.	Birmingham, Ala.	(See Remarks)				Reported planning extension to Chattanooga, Tenn.
G. L.	St. Louis Industrial Fuel Co.	St. Louis, Mo.	(See Remarks)				Plan to enter St. Louis for industrial loads with line from southwest.
G. L.	Wasatch Gas Company	Ogden, Utah	Ogden, Utah	Pocatello, Idaho	10"	140	Applied for permit to build welded line.

TABLE

O L.—oil line Ga. L.—gasoline line
G. L.—gas line



WHERE THE GOING IS "HOT"



Every line has its "hot spots"—places where the usual kinds of pipe just can't show performance—places where cinder fill, alkali soil, salt water and the like laugh at man's feeble effort to master them with ordinary ferrous pipe.

But there is a solution. Science has developed an alloy—Toncan Iron—of refined iron, copper and molybdenum, and Republic has developed a method for making it into electric weld pipe. This pipe in "hot spots" has shown greatly increased life for the simple reason that it ranks first among the ferrous metals, after stainless steel, in its resistance to corrosion.

Make this your policy. Wherever tests of soil or water show conditions which accelerate corrosion, take no chances—specify Toncan Iron Pipe. And for the balance of the line use Republic Electric Weld Steel Pipe. By no other means can you get a uniform life over the entire line as economically.

Two books that will interest you will be sent upon request—"Pipe for Permanence," telling the story of Toncan Iron, and Catalogue 210-B, giving complete information about Republic Electric Weld Pipe. Send for them.

REPUBLIC STEEL CORPORATION

GENERAL OFFICES YOUNGSTOWN, OHIO

The Month's Activities in Refining*

By F. R. STALEY

DUE to increased cracking the percentage yield of gasoline in February rose to 46 per cent, according to the Bureau of Mines figures, which is the highest recorded.

The M. W. Kellogg Company will construct a new cracking unit for the Magnolia Petroleum Company at Fort Worth.

The Alco Products Company was awarded a contract for the construction of two refining units for the manufacture of lubricating oils at Buenos Aires, Argentina.

The Imperial Oil Company, Ltd., will construct a refinery at Cartagenia, Columbia, S. A.

The Phillips Petroleum Company will construct a modern distillation unit and reforming equipment at Kansas City.

The Octane Refining Company, Chautauqua, Texas, started operations during the past month. The Donnelly Cracking Process is used.

The Bobrose Oil and Refineries, Inc., are planning the installation of large capacity cracking unit at Luling, Texas.

Black, Sivalls & Bryson, Inc., have constructed a vapor recovery and stabilizing plant at the Montreal refinery of the British American Oil Company, Ltd. The equipment included the first high-pressure welded vessels ever shipped into the Province of Quebec, and consisted of two bubble towers and three separators.

The Olympic Refining Company moved its 1,200-barrel plant from Lovell, Wyoming, to Baca, New Mexico. Crude will be delivered through pipe line from the Hospah Dome.

The Gewerkschaft Deutche Erdoel Raffinerie is now operating a new 75,000-ton cracking plant at Misburg, Germany.

Many oil companies are marketing new brands of high octane gasoline. Some of these are The Texas Company "Fire Chief," Richfield "Hi-Grade" and Shell "3-Energy" gasoline.

Doctor H. S. Taylor will speak on the "Fundamentals in the Problem of Resistance to Deterioration" before the annual meeting of the American Society for Testing Materials in Atlantic City in June.

Many technical papers dealing with gasoline and lubricants were presented at the second mid-year meeting of the American Petroleum Institute, Division of Refining, in Tulsa. T. A. Boyd discussed the relation of knock ratings to behavior of fuels in service. The detonation sub-committee is now engaged in working out a road test procedure in order to rate gasolines by means of it, and to find means of getting knock ratings on the C. F. R. unit which will predict the behavior of fuels in cars.

Natural Gasoline

The Economics of the Natural Gasoline Industry was discussed at the eleventh annual convention of the Natural Gasoline Association of America in Tulsa last month. This discussion was led by R. C. Alden of the Phillips Petroleum Company. He outlined and discussed the following problems of the industry: (1) Dependence on one market, (2) the double freight charge in reaching the ultimate consumer, (3) lack of storage facilities to provide for the seasonal demand for the product, (4) the failure in accounting in regard to the actual economic cost and value of natural gasoline.

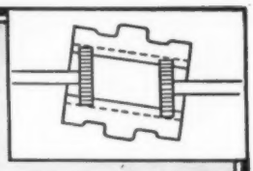
Refiners in the Central division increased crude runs while those in the other two divisions show a slight decrease.

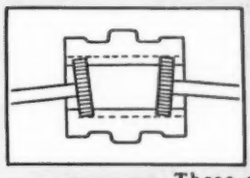
Economic and Technical Problems of the Liquefied-Gas Industry were outlined by Alois Kremser at the second mid-year meeting of the American Petroleum Institute. Gas-Cracking and Reforming Processes were discussed in a paper by G. G. Oberfell and J. A. Guyer.

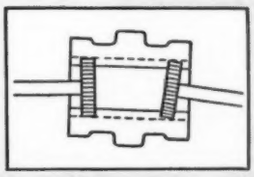
Figures in red show per cent refining capacity operated.

*All statistics as of June 1st.

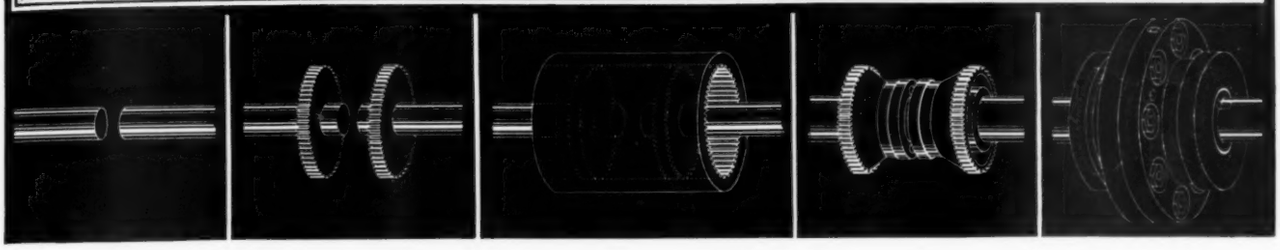
See How FAST'S *let you say Good-Bye to* COUPLING SHUT-DOWNS







These exaggerated diagrams show how all forms of misalignment are compensated for between the lubricated faces of the gear teeth. Note how the entire assembly rotates as a unit.

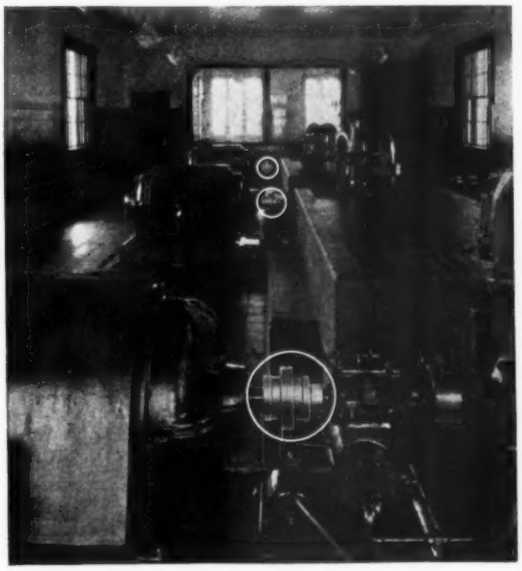


THE diagrams will show you how Fast's Coupling does away with all flexible pins, grids, washers, discs, or springs. And by substituting the simple mechanical assembly illustrated, for parts that might fatigue and breakdown, Fast's has made coupling shut-downs, and losses from them, a thing of the past.

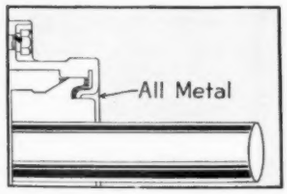
How simply Fast's Coupling works! Shaft misalignment is compensated for between the lubricated teeth of generated gears. Oil carries the load. Nothing to wear. Nothing to flex, fatigue or fail. Not a part that must be replaced periodically with attendant loss of time. Just oil Fast's Self-Aligning Coupling from time to time like any other piece of transmission machinery, and it will last as long as the connected machines—with no possibility of shut-downs.

Specify Fast's Couplings on all new equipment for your plant. It will free you from coupling trouble. Write for catalog showing a Fast's Coupling for almost every need of industry.

Above is shown the simple development of Fast's Self-Aligning Coupling. A spur gear on each shaft end, a sleeve with internal gears to mesh. Oil in the sleeve carries the load.



Fast's Self-Aligning Couplings at the Main Pumping Station, Pure Van Pipe Line Company, Van, Texas.



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Not a single flexible material, not a single rubber or felt washer is used in Fast's Coupling. All metal to metal contact prevents dust, grit, fumes or moisture from getting into the working assembly. Due to this exclusive Fast's principle, Fast's Couplings never cause shut-downs because of internal wear due to foreign substances.

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Effect of Sand Penetration and Selec

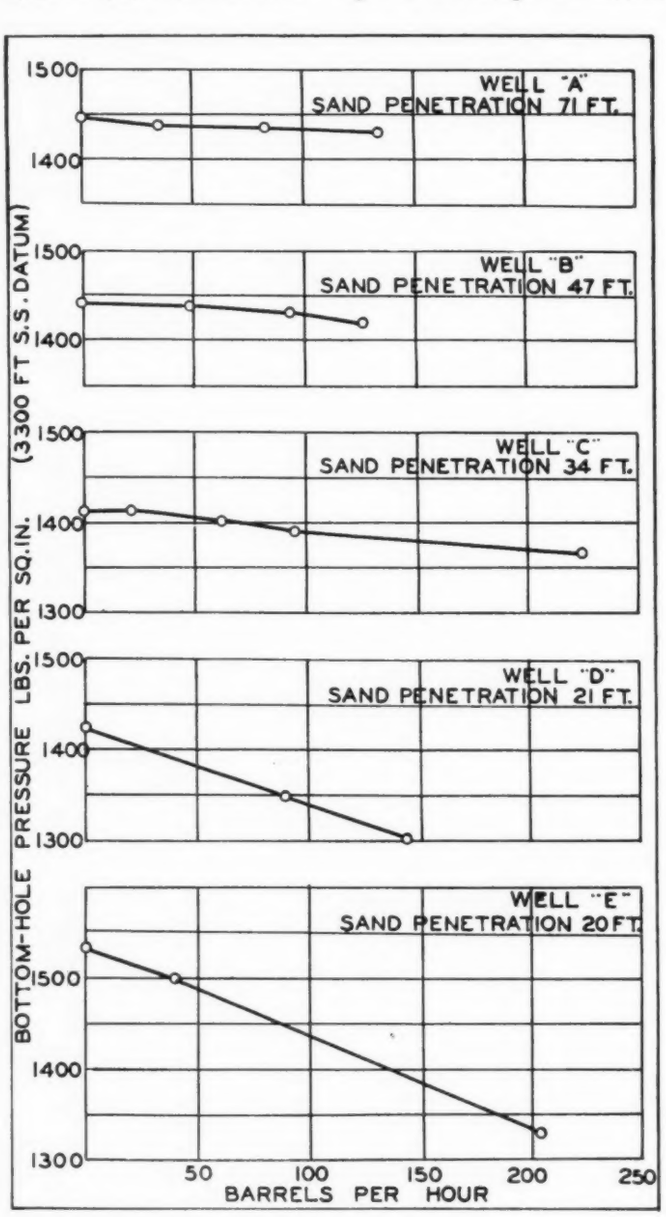
By K. C.

SINCE the inception of the practice of taking bottom-hole pressures in the East Texas field, petroleum engineers and operators are evincing a keen interest in bottom-hole data and are beginning to sense the practical value of this type of information, especially as it pertains to individual well operation. From bottom-hole pressure data alone, significant deductions have already been made in regard to changing reservoir conditions. Methods of well completion and well operation are beginning to be viewed in a new light. Those engaged in the interpretation of bottom-hole pressure records are being led into other related channels of practical investigation on bottom-hole conditions in order to supplement and more fully to comprehend the valuable information now in their possession. The remarkable results procured from bottom-hole pressure studies have increased the desire to seek a true and comprehensive picture of conditions at the bottom of the well and in the sand.

It is frequently found that the physical bottom-hole conditions run counter to what might have been expected, then the need immediately arises for more comprehensive bottom-hole data. As a result, besides pressure conditions, the physical and chemical characteristics of the fluids at the bottom are now being investigated. Samples of oil are taken under pressure from the bottom of the well and tested to determine the volume, and the composition of the gases in solution under the existing bottom-hole pressure and temperature. There are good grounds for the belief that field studies of this nature will be among the most far-reaching of any in influencing future development and production practice.

Heretofore, studies and investigations pertaining to the determination of reservoir conditions have been confined chiefly to laboratory experiments. Valuable papers have appeared in the last several years reporting the progress and results of such studies. Invaluable as the results of these studies are, much of their practical value has been lost, up to the present, because of the inability to correlate these results with field data and apply them to the solution of practical field problems. One of the greatest obstacles has been the lack of field data of sufficient accuracy that could be used and tied in with laboratory investigation. Laboratory experiments are, of necessity, made under ideal conditions that seldom, if ever, are encountered in actual practice. It now seems as if this obstacle of inadequate field data will soon be removed, so far as the production of oil and reservoir conditions are concerned, for the character of information on bottom-hole conditions now being obtained can be closely correlated with laboratory results and put to immediate practical use in field operations.

Some interesting observations have been made on wells in the East Texas field on the influence of sand penetration and diameter of hole on the productivity of the well. Several years ago the advantages of increasing the diameter of wells were advanced by L. C. Uren.[1] It was demonstrated, both physically and mathematically, by experimental evidence, that enlarging the diameter of the hole in the producing sand would not only increase the rate of production, but would also increase the drainage area of the well. As greater drainage area would mean wider well-spacing, the diameter of the hole in the sand may be an extremely important factor entering into a development program.



Set of curves showing the effect of Sand Penetration on bottom-hole pressure drop as the rate of flow is increased

In the East Texas field, a limitation is placed on the penetration of wells because of the presence of water in the producing sand. Where the thickness between the top of the producing sand and the water level is of very limited amount, an operator naturally wants to take every precaution to protect his well against water encroachment or possible water-coning.

By decreasing the amount of penetration and enlarging the diameter of the hole in the sand it may be possible to obtain the desired effective drainage for the well without incurring the risks incident to completing the well with a small hole and large penetration.

[1] "Increasing Production of Petroleum by Increasing Diameter of Wells," by Lester C. Uren, Trans. of the A.I.M.E., Volume LXXI, 1925.

tive Solubility in Wells Being Studied

SCLATER

That penetration influences the rate of production is clearly indicated in the two accompanying charts. These were plotted from data obtained in five wells, all completed in the sand with a hole of the same diameter but of different penetrations. In the chart with the five curves showing the barrels-per-hour plotted against bottom-hole pressure, it will be observed that in the wells of greatest penetration the rate of bottom-hole pressure-drop was least at increasing rates of flow.

In the other curve, the sand penetration is plotted against the drop in bottom-hole pressure per unit rate of flow. Here again, it will be observed, perhaps more clearly, that the drop in bottom-hole pressure per unit rate of flow is smaller the greater the penetration. The practical value of this information is obvious. It serves as a valuable guide in determining the proper penetration on subsequent wells to be drilled. It is a demonstration of the practical application of bottom-hole data to development and production problems.

Although much attention is being paid to the proper utilization of gas energy in the production of oil, comparatively little is known regarding the solubility of natural gases in crude oil as they exist in nature. Preliminary investigations[2] made on samples of natural gas-oil mixtures drawn from the casinghead of wells under high pressure, indicate that selective solubility plays an important part as the fluids issue from the well. More efficient utilization of the gas energy will be possible when more information is forthcoming on this all-important subject in the production of oil.

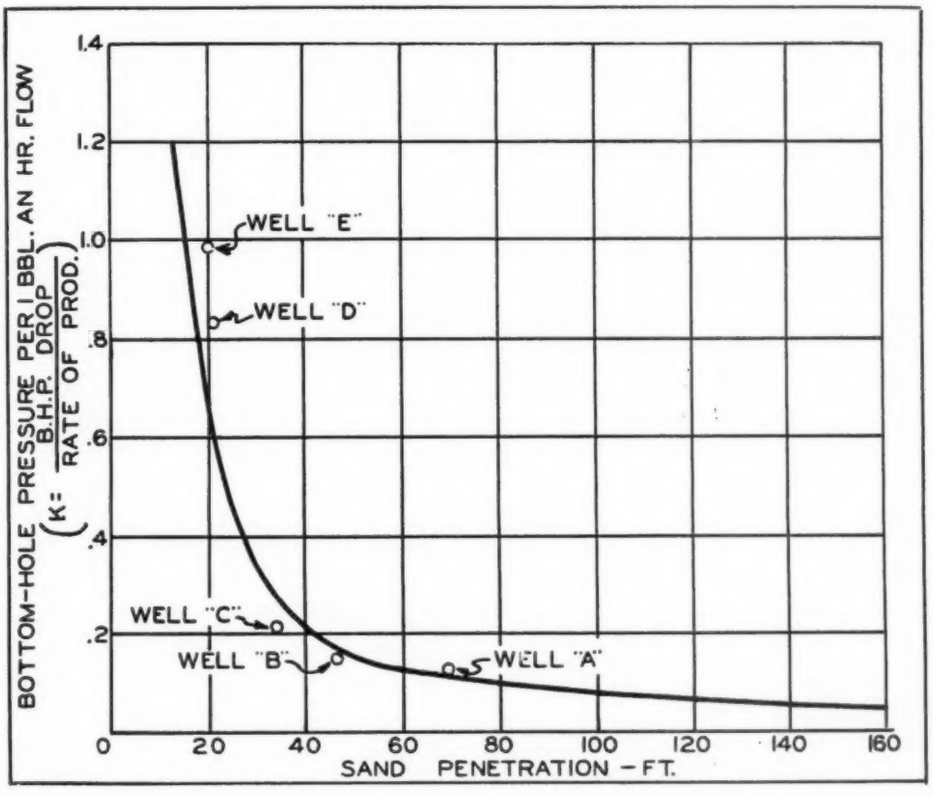
In the preliminary investigation just cited, Lindsly observed the effect of selective solubility in Kettleman Hills crude. Samples, drawn from the casinghead under a pressure of 1672 pounds absolute, had a gas-oil ratio of 230 cubic feet per barrel at 100 pounds pressure absolute, and a gas-oil ratio of only 800 cubic feet per barrel at 1672 pounds pressure absolute, or 3.48 times greater than at 100 pounds pressure, and not 16.72 times, as might have been assumed from the pressures. It was also revealed that at 1672 pounds pressure the ethane present was in the gaseous phase.

Similar tests made by Lindsly on crude from the Ventura Avenue field, California, showed that the propane in solution in the oil was greater in quantity than the ethane. The difference found in the proportions of the gas constituents in the Kettlemen Hills crude compared with that found in the Ventura Avenue crude in these preliminary investigations only serve to emphasize the wide variety of hydrocarbon fluid mixtures encountered in actual practice.

[2] "Preliminary Report on an Investigation of the Bureau of Mines Regarding the Solubility of Crude Oil," by Ben E. Lindsly. A.I.M.E. Petroleum Development and Technology, 1931.

The fluids in an oil reservoir are a mixture of hydrocarbons, some of which are liquids and some gases. They are all more or less highly miscible in each other. As the pressure is reduced and the gaseous components come out of solution the composition of the remaining liquid changes and its ability to hold other hydrocarbons in solution is correspondingly altered. Thus the progressive action of selective solubility occurs. At the same time there is a progressive change in the composition of the gas. Many of the early investigations on gas-oil mixtures did not take into account this action of selective solubility and the part that it plays in changing the composition of gas and liquid in gas-oil mixtures in reservoirs as they are produced from the well.

Another surprising fact revealed by Lindsly's investigations was the magnitude of the shrinkage that the oil undergoes as the heavier gases are released from solution. In Kettleman Hills crude, the total shrinkage of the mixture from 1672 pounds pressure absolute to atmosphere was 36 per cent, a total loss in volume of more than one-third of that occupied at 1672 pounds pressure. Of course, it should be understood that the tests made by Lindsly were carried out at 70 degrees F. and not at reservoir temperature. Assuming a constant temperature of 70 degrees F., it meant that for every 800 cubic feet of gas per barrel produced the shrinkage of the remaining liquid in the reservoir was roughly one-third of a barrel. The magnitude of this shrinkage is one that cannot be overlooked on depletion estimates, especially in pools of high gravity oil and large gas volume. It is to be borne in mind that this shrinkage, due to the liberation of gases, is in addition to normal depletion resulting from the withdrawal



Curve plotted from data of five wells showing the definite relationship existing between Sand Penetration and Bottom-Hole Pressure Drop

Pumping equipment on a well in East Texas

of production from the reservoir. The gravity of the oil tested at Kettleman Hills was 62.6 degrees A. P. I. The shrinkage loss is greatest when propane and the heavier gases are liberated from solution, and occurs at pressures below 200 pounds per square inch. Of the total shrinkage of 36 per cent just mentioned, only 15.5 per cent occurred between 1670 pounds pressure and 200 pounds pressure, and the remaining 20.5 per cent from 200 pounds to atmosphere pressure.

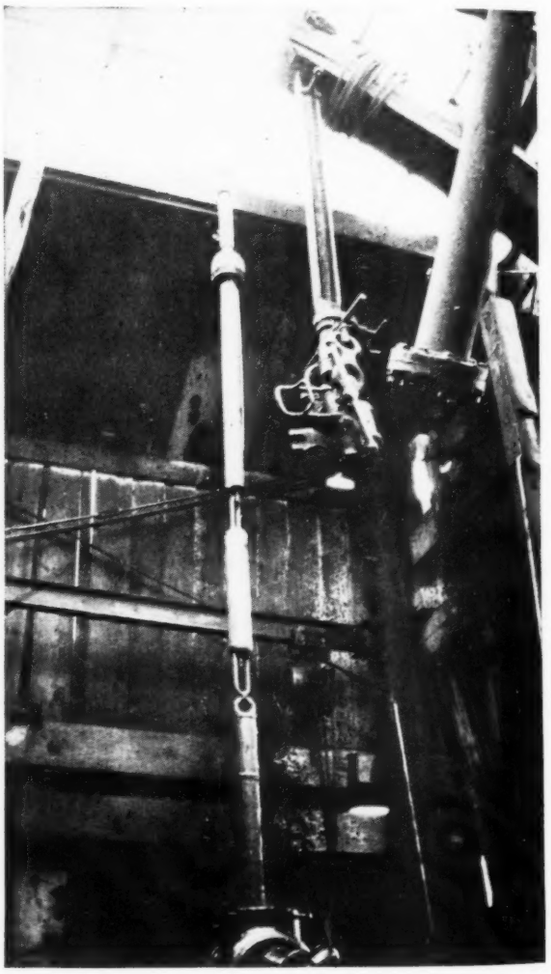
For Ventura Avenue crude of 35.0 gravity A. P. I., on which the pressure was reduced from 975 pounds pressure absolute to atmosphere, and for each 32,000 cubic feet gas produced, the shrinkage was found to be approximately 13 barrels. But this was the over-all shrinkage, actually the shrinkage due to liberation of heavy gases below 200 pounds pressure was determined to be about three times as great as that due to liberation of light gases at pressures above 200 pounds per square inch. In general, it can be said that the greater the pressure the greater the solubility of natural gases in crude oil, and the lower the temperature the greater the solubility. A high reservoir temperature, therefore, tends to lower the solubility of the gases in the oil. However, it is believed that the high temperature commonly encountered in deep high-pressure pools are not great enough to offset to any great extent the increased solubility due to high pressure. It would seem that pressure is of much greater importance than temperature in influencing the solubility of natural gases in the crude oil in the producing sand.

As only those hydrocarbon components in the gaseous phase in solution in the oil are efficacious in supplying the necessary energy required to drive the oil through the sand and into the well it is important to know what components exist in the gaseous phase and their volume. There is evidence indicating that perhaps the heavier gases take part to a much greater extent than is commonly believed. That is, a considerable quantity of the heavier gases may be in the gaseous phase under extremely high pressures and as such supply a corresponding quota of energy in moving the oil into the hole and lifting it to the surface. If methane forms a large part of the gaseous components present in the oil, as it generally does in the average oil pool, a considerable volume of the heavier gases, as butane, may be in the gaseous phase under reservoir pressures. This is explained on the basis of partial pressure considerations. The larger the percentage of methane, in contact with the oil in the reservoir, the lower will be the partial pressures of the heavier gases, hence a greater quantity of the heavier gases will be in the gaseous phase in the reservoir. Also if the reservoir temperature is high it would further assist in maintaining a larger volume of heavy components in the gaseous phase.

It can be realized from a consideration of these aspects of solubility of natural gases in crude oil the important influence solubility has in the production of oil. If the composition and volume of the gases present in the oil at the bottom of a well can be determined, and also the composition and general character of the oil itself, the problem of efficient production of the well can be greatly simplified.

A bomb for taking a sample of the fluids at the bottom of the hole and bringing it to the surface under pressure for analysis, offers a means of procuring this information.

Investigations with these instruments are now being made in the East Texas field by engineers of the United States Bureau of Mines. This work is a continuation of the preliminary investigations, already referred to, that began about two years ago. Invaluable data on the technique of analyzing reservoir conditions and well operation are expected to result from these investigations.



Bottom-hole sampler, pressure bomb and temperature bomb being run in a well in Oklahoma. This picture was taken several years ago during the development of a bottom-hole sampling device.

Reclamation Project Causes Difficult Stream Crossing

By J. H. DAMERON

LAYING a river crossing before the existence of the river's channel rarely happens in pipe line construction work, but such a task was recently completed by the Lone Star Gas Company. Ordinarily a construction program of this nature would be the ideal in river crossing work, but due to unfavorable weather conditions and unforeseen obstacles, the work perhaps entailed more difficulties than the conventional method of laying a multiple line river crossing. The work developed many exceptional problems.

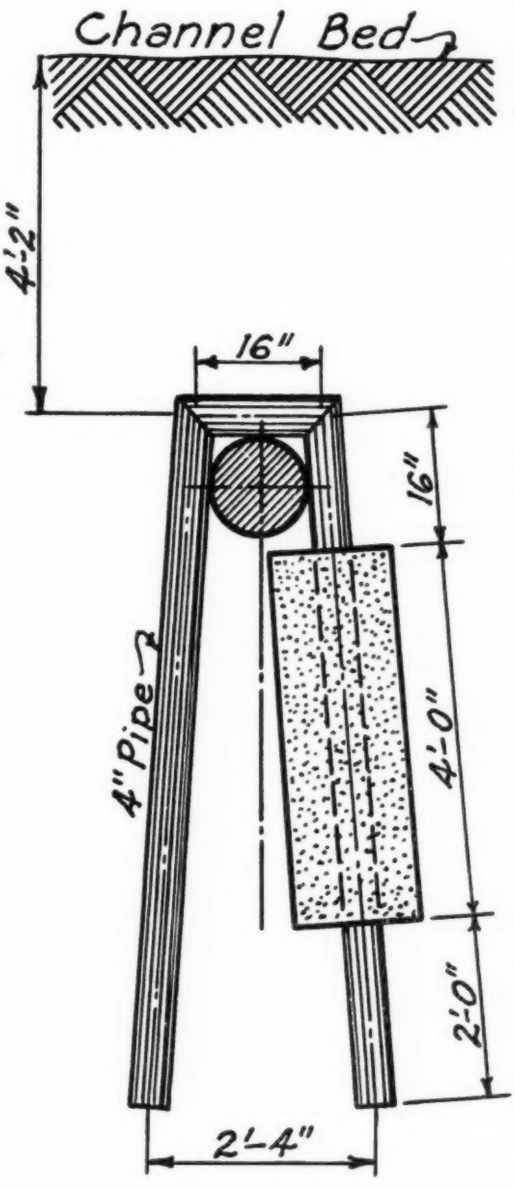
The crossing job was occasioned when several hundred acres of flood land area was reclaimed in the Trinity River bottom near Dallas, Texas. This was done by changing the course of the river, cutting a new diversion channel, and building a levee on the east bank to make a 1,000-foot floodway which is designed to care for high water during flood stages. A few hundred feet back of the west bank is a hill affording a natural levee on that side. The new channel is 25 feet deep and 300 feet wide.

Formerly the pipe line system crossed the river at two widely separated points with multiple river crossings for its two 16-inch lines coming into Dallas. The new channel made it possible to make one crossing for the two 16-inch high pressure lines. The new crossing design called for 16-inch lines in the floodway and swaged down to 12-inch lines approaching and crossing the river bed, which was 150 feet in width. Construction of the first crossing presented the ideal condition. The old line in the floodway was taken up and replaced with 16-inch pipe acetylene welded. At a point near the bank of the river the 16-inch was swaged down to 12-inch.

When the line was laid one of the draglines cutting the new channel worked up and down the crossing; side cutting down to a depth of 25 feet. When this work was finished the machine cut a trench across the channel to permit burying the line four feet beneath the river bed. The spoil dirt from the excavation was thrown on either bank of the channel and is being permitted to wash away.

The 20-foot random lengths of extra heavy river pipe were strung in the channel and lined up on skids. The 150-foot section for the river bed was welded, as were the two vertical sections comprising that part of the crossing climbing up the sides of the channel. When this work was completed the pipe was cut with a torch at the angles so welders could make the bends with mitre welds.

All welds are reinforced with straps one and one-eighth by seven-eighths by eight inches. The reinforcements were welded to the pipe edgeways instead of flat in order to obtain more strength from the reinforcing straps. Small half circles were cut in the center of one edge of the straps so they could be fitted over the joint weld. Four straps were used to reinforce each of the straight joint welds and were equally spaced around the circumference of the pipe. Only three straps were used to reinforce the mitre welds. None of the mitre welds were reinforced at the throats but on the outside center and on the two sides. Generating equipment for the welders was located on the bank of the channel and welding torches were fed through long oxygen and acetylene hose.



Anchor for Channel Line

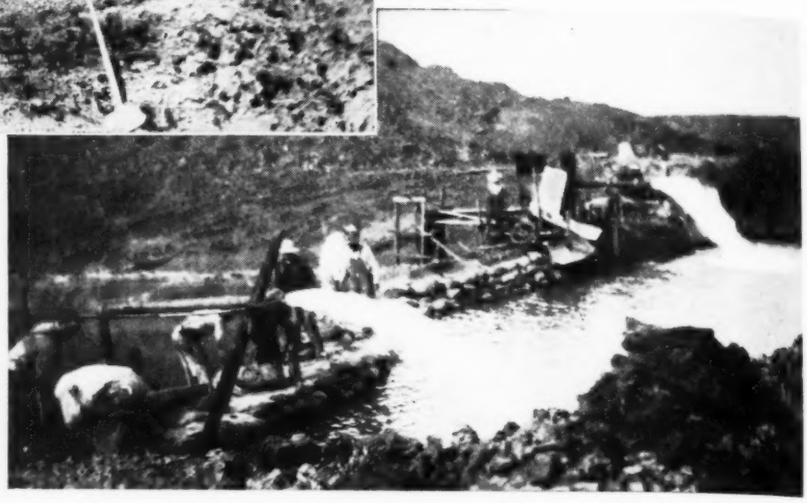
When the line was ready to be lowered into the trench after being coated with a cold application of paint, forms were made for concrete blocks used to anchor the line in the channel. Anchors were spaced approximately 20 feet apart. The shape and method of anchoring the pipe to the blocks are illustrated by one of the accompanying drawings. Channel anchors are made by means of four-inch pipe fabricated into inverted "U" placed over the pipe, and driving it in the river bed. The four-foot concrete block is poured after the inverted "U" is driven into place. The 16-inch line crossing the floodway was anchored down with four-foot-square concrete blocks spaced approximately 35 feet apart. Gate valves were set in concrete gate boxes.

With the first line across and covered, the construction gang moved down the channel about 400 feet, and expects to complete that crossing with equal dispatch.

As the excavation work for the second line drew to a close, intermittent rainfall made the river bottom a sea of mud. One of the forks of the river rose, and back water from it found its way into the cut for the new channel. With three feet of water standing in the river bed, plans to lay the second line by following the same methods used to build the first line were abandoned.

Left: General view, showing excavation made to repair broken line.

Below: Pumping water over coffer-dam preparatory to repairing break.



The entire section of 12-inch, making up the stream crossing, was welded into one section on the west bank of the river. The welds were reinforced with straps and the line was coated. A tractor equipped with a front end winch was anchored on the east shore and used to pull the welded section across.

The ends of the pipe were closed with temporary plugs to keep out mud and the section was pulled across without trouble. Once the section was swung across the channel another tractor line was connected to the pipe.

As it was desired to cut the section with a cutting torch at the two angles in the bottom of the crossing, lowering horses were set up on the slope of the channel bank. These, with the tractors, held the section sufficiently rigid for cutting so a mitre weld could be made. After the cut was made the pipe was lined up and tack welded. Following completion of the bell hole mitre weld, the weld was reinforced and the same procedure followed on the slope of the opposite bank to make the mitre weld for the channel bed bend on that side.

When both mitre welds were ready the section roughly resembling a square "U" was lowered in the four-foot trench. The cut for the mitre welds was then made. Because of the water in the channel it was decided not to anchor the channel bed section of the crossing with concrete blocks. Moving up the slope of the channel bank just far enough to be above the shallow water, forms were made for the concrete anchors by digging anchor holes near the mitre welds. Concrete was poured in these after the anchor irons had been dropped over the pipe.

Shortly after the crossing had been completed, a drag line working in the channel started to slip and the machine's bucket struck the pipe. The line was loaded at the time, carrying about 150 pounds pressure. When the line was torn away gas roared out, sending a spray of water around the machine which did not ignite the gas. As the machine was working down stream, water had filled the upstream side of the cut to a depth of 13 feet.

A coffer-dam was built across the channel above the break by means of sand bags and mud. When this work was completed a pair of centrifugal pumps were located on top of the coffer-dam. It required about five days' pumping time to remove all the water. When the water was removed gangs working in mud uncovered the line and it was found necessary to remove several lengths of pipe. New lengths of pipe were lowered in the sloppy ditch and welded in the same manner as the welding on the first line laid across the channel. Upon completion of the work the equipment was removed from the coffer-dam, which was later cut, and permitted to wash downstream.

Rigging up pump connections on coffer-dam

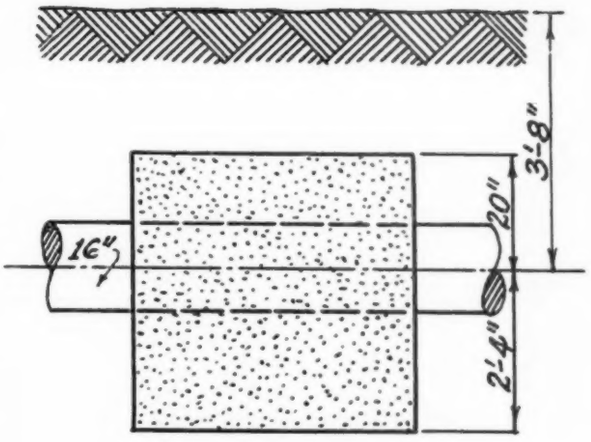
Laying the line across the 1,000-foot floodway was slow work, but not nearly so difficult as the construction of the two channel crossings. This section of the line was built with 16-inch welded pipe, with each weld reinforced with straps. The trench for the line was cut to give about

a four-foot cover and the line was weighted down with concrete anchors.

Most of the difficulty encountered in the floodway was in the moving of material. Most of the time crews worked in mud. Frequently the tractors would sink 18 to 24 inches. Whenever this happened the winch line of the tractor was fastened to some suitable anchor and the machine pulled by spooling in the winch line.

On the line going into North Dallas it was not necessary to take up the pipe except in the floodway for the new channel. The old multiple river crossing for this line was taken up when the river was diverted to the new channel. This was replaced by a single 16-inch line.

Considerable difficulty was experienced in laying the new line for the 16-inch going to South Dallas. The old line, which had been in for years, was taken up and the pipe salvaged. The new line follows the levee for a considerable distance. It was chiefly built of 20-inch pipe, and anchored as the lines crossed the floodway.



Concrete Anchor Block for 16-inch line

In building the levee the contractors obtained the dirt from bar pits dug close to the levee burn. The burn offered a narrow roadway which was the most practical to use in the movement of material and supplies. This narrow roadway would not permit the turning of trucks. When a truckload of pipe was brought in, a tractor followed close behind and when stringing was finished the tractor pulled the truck back to a point where it could be turned around.

Regulations would not permit the transmission company to lay its line under the levee but required the building of the 16-inch lines over the levee. These were covered with about four feet of dirt and anchored at the foot of the levee on both sides of the foot of the levee with concrete anchors. The 12-inch gates were set in concrete gate boxes near the burn of the levee.

At the same time this work was in progress another crew built a lateral line along the levee burn connecting the two 16-inch crossings. In the event either of the two crossings fail gas may be delivered through the remaining line to the two lines going to the main measuring stations.

After the line following the levee burn had been partially completed, the location of a water pump station on the levee was changed, placing the station directly over the gas line. Rather than make a change in several hundred feet of piping the transmission company laid its line around the station. To reduce the strain that might be imposed on the line at this point sleeve type expansion joints were installed and the line anchored with concrete.

Upon completion of the entire change the line was tested with gas and no leaks were discovered. No trouble due to the line being carried downstream is anticipated. The current is not swift and the lines are amply weighted down and anchored.

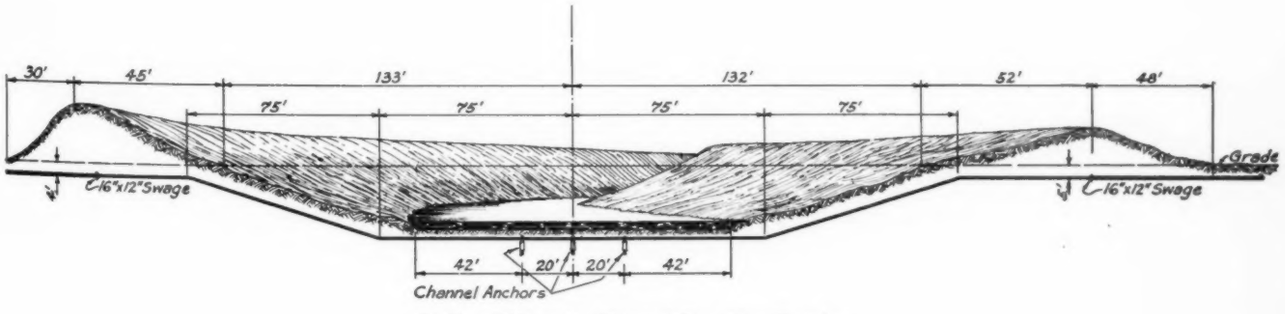
Ditching along the levee burn proved exceptionally difficult for the most part. The burn ranges from 12 to 14 feet in width and it was necessary to lay the line on the outside of the burn, because a rail line is expected to be built on the burn in the future.

When possible, the transmission company had its ditching crews working ahead of the drag line. When this was done, a ditching machine was operated and cut the ditch about 50 inches deep. Back water, however, retarded the progress of the machine and the drag lines building the levee made it impossible to use the machine further when they caught up with ditching operations.

Ditching by hand retarded progress greatly because of the severe conditions under which the crews worked. The soil is waxy and difficult to handle when wet. In some instances it caved badly, necessitating recutting of the ditch.

Aligning the pipe was equally difficult for the laying crews. The tractors had difficulty in pulling through the sticky mud and would sink deeper with the added load of a length or a section of 20-inch pipe. The same disagreeable conditions made it difficult to clean the pipe preparatory to applying a protective coating to the line before lowering it in the trench. The back-filling was accomplished with bull-dozers and by hand labor. Aside from the movement of welding equipment the welding offered few difficulties. Once on skids, the welders' helpers could easily handle a section of pipe, although the skids would sink slightly as the pipe was rolled for a roll weld.

In taking up the old line, hand labor was used throughout to strip the pipe. As rapidly as the line was uncovered, it was raised and placed on skids, the couplings removed and the lengths loaded on trucks. It is interesting to note that the mill marks on many lengths salvaged could be read easily. The pipe had been in the ground more than twenty years.



Profile of Diversion Channel Pipe Line Crossing

The Laboratory Assay of Crude

By A. W. TRUSTY
Chief Chemist Louisiana Oil Refining Co., Shreveport, La.

CRUDE petroleum varys widely in its chemical and physical characteristics. Some crudes contain corrosive salt compounds which present serious refining problems; other crudes contain large amounts of asphalt which makes them undesirable for cracking stocks; other crudes are sweet, produce high gasoline yields and present the minimum of refining trouble. By a complete laboratory assay of sample of crude oil representative of the field from which it is taken, all yields, corrosion problems, treating problems, cracking characteristics, etc., can be predicted very accurately. By experience, the laboratory yields and estimates can be correlated with actual plant yields on crudes previously processed and comparative figures can be established.

An analysis of East Texas crude accompanies this article.

The apparatus used for atmospheric distillation of crudes consists of a three-liter pyrex balloon flask with a 1 x14-inch Hempel fractionating column, packed with either glass beads or aluminum rings, and connected to a suitable condenser.

Two thousand c.c. of the crude is charged into the flask, and the distillation begun. The vapor temperature and the gravity of the overhead is noted for each 2.5 or 5 per cent fraction. By experience the operator can tell by the vapor temperature very closely where the fraction should be cut for any desired end point gasoline. After the kerosene, which is cut for either end point or gravity, has been taken off, the distillation is stopped for sufficient time to exchange the fractionating column for a short curved iron connection (goose-neck) connected the distilling flask directly into the condenser, permitting the distillation to be continued with the minimum of reflux. The gas oil is distilled over, leaving a residuum in the flask of any desired gravity. A convenient method of obtaining any gravity residuum is to take the last three or four overhead gas oil cuts off in 2 per cent fractions, and to carry the distillation slightly beyond the point to obtain the desired gravity of residuum. Discontinue the distillation, take the gravity of the residue and if the gravity is lower than was desired, blend back sufficient of the last heavy gas oil cuts to give the desired gravity.

A convenient method of running vacuum distillations on crudes to determine either the yield and quality of lubricating oil or of asphalt is as follows:

After the gasoline and kerosene has been topped off through the Hempel fractionating column as described above, the Hempel column is removed and the short connection (a piece of ¼-inch pipe bent is most satisfactory) is used to connect the flask and the iron (preferably) condenser. A vacuum desiccator with a hole in the top is used to receive the fractions. Two hundred c.c., 250 or 400 c.s. beakers are placed in a circle in the desiccator. A piece of ¼-inch glass tubing bent at a right angle is inserted in a two-hole rubber stopper in the hole in the top of the desiccator and the end of the glass tubing adjusted so that it can be turned to deliver oil in any of the beakers in the desiccator. The other end of the glass tubing is connected to the end of the condenser with a piece of rubber tubing. The vacuum line is connected to the other hole in the two-hole rubber stopper. By this arrangement, the distillation can be completed without interruption, as is the case where "cuts" are made from one flask into another. The beakers may be marked with rubber bands to denote any desired volume to be taken as a cut.

Distillation, sulphur, corrosion, doctors, color and knock rating determinations are made on the gasoline fraction. From the distillation, and subsequent blends with natural gasoline to meet commercial gasoline specifications, the amount of natural gasoline which will be required for plant blending can be determined. If the gasoline is doctor sour, the amount of litharge required to doctor sweeten can be determined as follows:

Agitate 1000 c.c. of the gasoline with 50 c.c. of standard doctor solution. Settle and drain the doctor solution. Determine the lead content of both the fresh doctor and the used doctor solution, by the volumetric molybdate method. By the difference in the lead contents of the doctor solutions and with the volume of gasoline treated, the litharge necessary to sweeten a barrel can be calculated.

If the sulphur content is higher than .10 per cent acid treats are made to determine the cost and treatment necessary to reduce the sulphur to the maximum limit of .10 per cent.

The same determinations are made on the kerosene as on the gasoline. Burning tests in a standard daylight lamp are also made to determine the burning quality of the kerosene.

As low a carbon residue as possible is desired, which means that the relative coking tendency will be low. A high aniline number indicates that the oil is paraffinic in nature and will crack at a relatively low temperature. A low aniline number indicates that the oil is naphthenic or asphaltic in nature and will require relatively higher temperatures for cracking. However, the gas oil with the lowest aniline number produces the best anti-knock gasoline. If the gas oil fraction is classed as a "heavy gas oil," the oil will crack at a much lower temperture than the equivalent hydrocarbons classed as a "light gas oil."

TESTS ON EAST TEXAS CRUDE

Gravity, 39.0; Flash, BRT; Fire, BRT; Tar. No., 14; Visc. @ 50°F., 100; Visc. @ 100F°., 42; Pour Point, 25°F.; B. S. & W., 0.2; Sulphur, .30; Color, Green-Black
Distillation of 2 liters sample at atmospheric pressure. Overpoint 65°F.

Cuts	Vapor Temp.	Gravity	Grav. on Composite	Cuts	Vapor Temp.	Gravity	Grav. on Composite	Cuts	Vapor Temp.	Gravity	Grav. on Composite
5.0	149	80.0	82.8	35.0	393	44.6	59.5	65.0	685	31.9	35.2
10.0	215	64.9	75.7	40.0	422	41.8	41.4	70.0	704	31.3	34.6
15.0	242	59.3	70.6	45.0	538	37.8	38.5	75.0	718	30.9	34.0
20.0	270	56.0	67.1	50.0	578	36.4	37.5	80.0	725	30.0	33.5
25.0	310	52.8	64.4	55.0	616	34.7	36.7	85.5	734	30.3	33.2
30.0	370	48.1	61.9	60.0	660	33.5	35.9	90.0	.....	.....	.....

Gasoline and kerosene were distilled through Hempel column.

SUMMARY

Products	Percent	Vapor Temp.	Gravity	Flash	Fire	Viscosity	P. T.	Tar No.	Color
Gasoline	38.0	406	58.8	.....	.....	.....	.....	.....	30+
Kerosene	3.0	448	41.5	.....	.....	.....	.....	.....	.....
Gas Oil	45.0	740	33.0	170	200	53/100	80°F	4	3
Residue	12.0	.....	12.0	330	485	500/122	100°F	.....	.....
Water	0	.....	.....	.....	.....	.....	.....	.....	.....
Loss	2.0	.....	.....	.....	.....	.....	.....	.....	.....

DISTILLATION

	Gas Oil	Kerosene
Gravity	33.0	41.5
I. B. P.	395	360
10%	500	414
50%	624	437
80%	750	456

Aniline No. 178°F.

DISTILLATION ON GASOLINE CUT

Gravity	58.8 API	Octane No.	59
I. B. P.	100 F		
10%	165	Recovery	97.5%
50%	268	Sulphur	.01%
90%	382	Doctor	Sweet

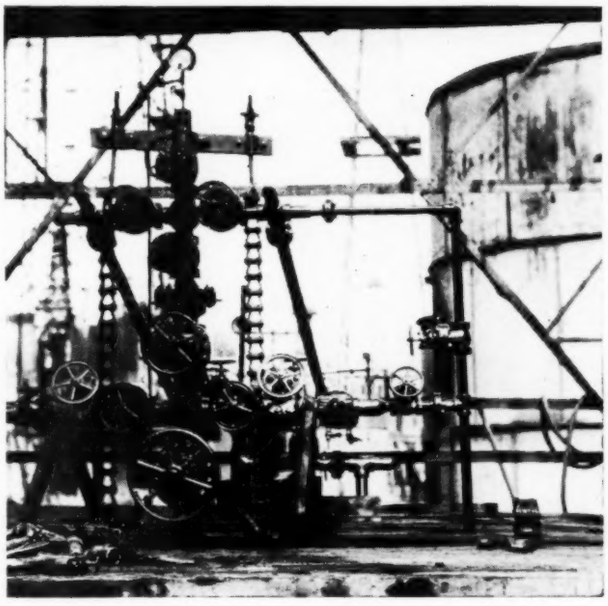
Gas Conservation Is Advancement in Producing Efficiency

By WARREN L. BAKER

CONSERVATION of reservoir gas energy or pressure is the new universally accepted means of efficient oil production. It may be expected to play a most important part in changing the industry's future producing methods and, when more fully developed and adopted, should enable the country's operators to recover a larger percentage of the oil existing in any known oil pool than ever would have been anticipated according to former prevailing ideas of oil recovery.

The industry has been steadily advancing toward this idea of an efficient producing practice for many years, but it remained for the general economic conditions, greater knowledge and resulting advanced technique, together with improved equipment, of the past few years, to give tremendous impetus to the movement.

The first step in this direction was the application of artificial forces to oil reservoir sands for the purpose of restoring the pressure in depleted or nearly depleted pools. The new conception is different from this older method in that (1) it is not a pressure restoration plan but one of pressure maintenance, (2) it is applied immediately upon the completion of the well or wells, rather than awaiting the time when the natural or original pressure is practically depleted, and (3) it is a utilization of natural forces rather than the use of artificial factors.



Christmas Tree on well that has been tubed while flowing

This new producing policy, that may be termed either as pressure maintenance or conservation of gas energy, is largely the result of serious attention devoted during the last few years by engineers and other operating men, to the fundamental principles governing the production of oil. As the study of these principles has progressed, it has become more and more evident, from the viewpoint of efficient recovery, that too little consideration has been given to the physical conditions and the various forces at work in the reservoir itself.

The study of these fundamental producing principles has led to the adoption of the belief that the measure of efficiency in oil recovery is the quantity of gas produced per barrel of oil and that the smaller the gas-oil ratio, or gas factor, the greater is the efficiency of recovery. The gas factor is defined as the number of cubic feet of free gas produced with a barrel of oil. Therefore, the subject of pressure maintenance evolves itself into one of gas-oil ratio control, with the object being to produce as much oil possible with the lowest amount of free gas.

Gas is the most important factor in moving oil from the reservoir sands to the bottom of the well, thence upwards through the flow string to the surface. It accomplishes this work in two ways, namely: by driving the oil before it when it expands and by friction as a result of its velocity of flow. Whenever a reduced outlet at the well is provided, a certain amount of back pressure is applied against the natural rate of oil flow, the amount of back pressure depending upon the original pressure of the well and the size of the opening, and this retards the flow velocity and expansion of gas, which action permits a smaller amount of gas to carry the oil to the surface.

The application of this principle maintains the pressure of oil wells at a higher level for a longer period of time; in other words, the decline in pressure is much slower than normal, thereby prolonging the flowing life and increasing the ultimate recovery of oil. The ultimate production will be increased because of the prolongation of the well's flowing life if the gas-oil ratio is decreased and vice versa. If the gas-oil ratio of a well is 750 cubic feet per barrel during open flow and the gas factor is cut to 500 cubic feet a barrel by applying a control, it means that on every barrel of oil produced 250 cubic feet of gas energy is saved. It therefore follows that, whenever two barrels of oil are produced at 500 cubic feet gas factor sufficient energy has been conserved to lift an additional barrel of oil, which normally would not have been lifted.

Obviously, the adoption of a gas conservation policy for an entire field during the early stages of development would force a steady gas production over a sustained period of time and this would permit an economical utilization of the gas produced with the oil. This additional large advantage would permit natural gasoline plants to economically strip more of the gas of its gasoline content and gas companies would often be warranted in constructing transportation lines to areas previously given little thought.

Unfortunately, there are no means of arbitrarily fixing a set ratio of oil to gas that may be applied to any well or field. Each well is an individual proposition, as the work of lifting oil to the surface increases proportionately with the depth; therefore, if the well is deep more energy, and, consequently, more gas per barrel is necessary to raise the oil to the surface. Many other factors, such as rock pressure, viscosity of oil and the well's position on the structure enter into the problem of establishing the most efficient gas-oil ratio.

It has been found that considerable experimenting is necessary on each well before the right gas factor can be determined

and it is also necessary to change the ratio from time to time as the bottom-hole pressures decline.

The growing appreciation of the great value of gas energy as an important agency in efficiently and economically producing oil and the greater realization of the important effect secured when gas pressure is conserved has unquestionably resulted in the now fairly common field practice of bringing wells into production by means and with equipment providing efficient control of the gas-oil ratio.

Conservation of oil and gas in competitive areas has been furthered more by proration than by any other factor. Prior to the advent of proration, conservation was limited to a very few areas. Proration has been a large factor in the development of the gas conservation policy, due to its enforced curtailment of production from each well in many pools. This curtailment of production from a given well, in most cases, has been achieved by providing a reduced oil outlet, resulting in the conservation of gas through means of back pressure.

Methods of Applying Gas-Oil Ratio Control

Reservoir gas has been conserved by flowing wells through tubing, by bottom-hole choking, surface chokes, and other means of restricting the flow, or a combination of these methods, all of which secure lower gas-oil ratios.

Adjustable Flow Bean on a well in the East Texas Oil Field

It is obvious that if pressure maintenance is to be accomplished in its highest degree, steps must be taken immediately upon the completion of the well to conserve the gas factor, or, otherwise, a proportion of the gas that might have been saved, will escape and it can never be recovered again. Therefore, we find many operators providing means for controlling the gas-oil ratio immediately upon completion of a well.

A pipe of small diameter allows gas less opportunity to rise through the oil in the pipe, hence the gas present in the oil column within a small pipe is more effective in causing movement of the oil. The use of tubing for flowing has become common in many areas of the country for this reason, particularly so in California and the Gulf Coast regions, and tubing is now being adopted in many other parts of the country.

Data from representative wells in the Yates field has shown the following advantages when using tubing as the flow string: increased production from small wells that did not have sufficient gas to produce steadily through casing; a delay in water encroachment due to the back pressure applied; removal of water upon its first appearance; and gas conservation due to a reduction in gas-oil factor.

A most important development in tubing of wells is the development of equipment and perfection of a method for tubing large-volume high-pressure oil and gas wells without loss of production. The ability to bring in deep wells through casing and then, immediately after their completion, regardless of volume or pressure, to tube them with the size of tubing that permits the most efficient use of the gas present is a decided advantage in maintaining pressure of deep wells; where the pressure is usually very high and the gas factor likely to be excessive.

Another rather new development in the practice of tubing wells is the use of tapered strings and adaptation of smaller diameter tubing. In the East Texas field, where all wells are tubed immediately upon completion, it has been found that if a well is allowed to produce under steady flow at three barrels per hour (the present allowable recovery) the gas-oil ratio with tapered tubing will be about 370 cubic feet per barrel of oil and the same rate through 2½-inch tubing gives an approximate ratio of 455 cubic feet per barrel.

A most interesting installation of small tubing has been that of The Texas Company in Osage County, Okla. A number of wells in the Atlantic City pool had been pumped for several years, but after injecting dry gas into the sand for a year and running small tapered tubing the wells commenced to make their production under natural flow. The tubing used on these wells is from ⅜ to one-inch in diameter and was run inside the two-inch tubing, which had been used for pumping purposes. The tremendous success of the application of small tubing to these old producing wells is better shown by the fact that their production ranges from five to twenty-five barrels per day and that the pressure is but slightly in excess of 400 pounds.

The Phillips Petroleum Company has demonstrated the feasibility of properly restricting the flow of high-pressure large-volume wells with a flow bean or choke by successful application of this type equipment to its Oklahoma City producers. The effect of choking a well, whereby the outlet is reduced, is to place back pressure on the oil flow, having the effect of lowering its velocity. The Phillips Company has found that in addition to reducing the gas-oil ratios, it has been able invariably to increase the gravity of the oil produced. They have found that usually wherever the best gas factor is found the highest gravity of oil is also obtained. On one of the company's wells an increase in the value of the oil produced (under proration) because of its higher gravity averaged $732.00 monthly over a period of nearly eight months. This greater revenue per produced barrel and the saving of an estimated one million cubic feet of gas has caused the company to place adjustable flow beans on all of its Wilcox sand wells in the Oklahoma City field.

The latest development in choking wells is the bottom-hole choke, which has met with great success. This device is placed at the bottom of the tubing string and pinches the flow at this point instead of at the surface. In several installations in the Greater Seminole area, the Indian Territory Illuminating Oil Company has had wonderful success in retarding the amount of gas produced per barrel of oil and the long flowing life of some of these wells has not been short of remarkable.

Another means of placing back pressure on a well is with the gas pressure regulating mechanism of a trap. While oil and gas traps are used primarily as separators, any back pressure can be held on a well up to the trap's safe working pressure.

The most frequently used combination of the various methods of applying back-pressure is that of tubing and adjustable chokes. In many cases, the application of both types of equipment on a well is an improvement over the use of either one alone.

The Property of Oiliness

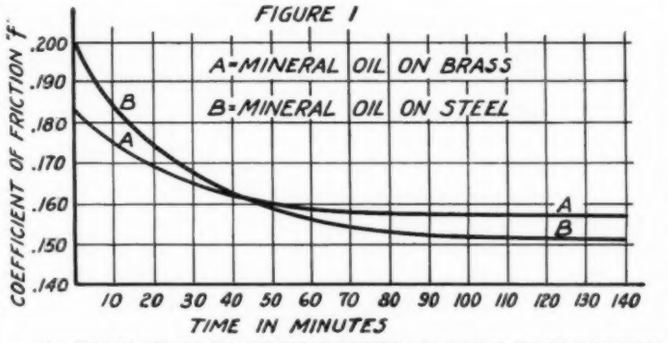
By H. B. BATCHELOR, Research Chemist

EVERY part of a machine that slides on or moves over another part must overcome the resistance that is called friction, which is in evidence from the slightest motion to the highest speed. There are two types of friction, unlubricated or solid friction, and friction of lubricated surfaces. The friction that interests the lubricating engineer is the friction of lubricated surfaces, which consists of two kinds, static friction and fluid friction.

Static Friction

There are two theories for static friction: first, the theory of the irregularities of the surfaces, and second, the molecular attraction theory. Coulomb's theory of the irregularities of the surfaces teaches us that a solid surface although highly polished, is never perfectly smooth, but has small projections called asperites. Static friction is caused by the interlocking of these irregular surfaces even if covered by a film of oil. Mr. W. C. Wilharm in experimenting with metals in a bearing found on examining under a microscope the surfaces where motion had occurred, that the softer metal had worn away and the harder metal had been built up. The question may arise, why one metal was cut away when the surfaces were actually separated by a film of oil. This is easily answered by the following example. A cutting tool in cutting a piece of metal is exerting no more than the wedge action of a tool between the chip and the parent metal. Picture then, that these metal surfaces are covered with asperites acting as minute chisels covered with a film of oil working on the metal surface.

FIGURE 1



COEFFICIENT OF FRICTION PLOTTED AGAINST TIME, SHOWING THE READINGS OF THE HERSCHEL OILINESS MACHINE AT TEN MINUTE INTERVALS.

When lubricated surfaces remain at rest for a period of time the oil film is more or less pressed out and the asperites puncture the film, making a certain amount of metal-to-metal contact. The result is that on starting motion the static coefficient of friction will approach the value of solid friction. Increase in pressure between the surfaces in contact increases the coefficient of friction, that is, causes interlocking of more of the asperites.

Many authorities do not agree with the theory discussed above, but attribute the friction to molecular-attraction, and explain the reduction of friction by stating that various chemical substances dissipate the attractive forces of the two surfaces through the absorbed film. There is no doubt that we do come in contact with properties or effects from both theories, but there is not a known way to measure or determine the small per cent of friction that is caused by the molecular-attraction. Knowledge of the theories suggests that the greatest per cent of friction is caused by the irregularities of the surfaces.

Fluid Friction

Fluid friction makes its appearance in shafts and rotating journals and bearings. In actual practice unlubricated bearings happen only through carelessness, but in many types of bearings the lubrication is inadequate because journal movement is much slower than that for which it was designed. This happens in nearly every case when the machine is started and stopped. We have learned by experience that as the speed of the journal increases the frictional resistance becomes less. This is attributed to the influence of the rotating surface to build up a thick film of oil around itself. The greater the speed the greater the tendency this film has to increase, even persisting under heavy loads. In the regime of fluid lubrication the friction is governed by different conditions of the lubricant, bearing, and speed. This fluid film lubrication is an ideal state, but no machine can run its entire life in this regime.

Oiliness

In slow speed, heavy loads, or in starting and stopping, the fluid film becomes ruptured and another property of the oil has to be considered. This property is called oiliness. By oiliness is meant the power of the oil to reduce friction when there is a metal-to-metal contact. All oils, therefore, possess oiliness, but some possess the property to a greater degree than others. Also the lubricant may show a greater degree of oiliness on one metal than on another.

In this oiliness regime an oil must form a tenacious film over the metal surfaces, reduce the friction, and prevent abrasion. Therefore, the lubricant must have the power to wet or spread over the surface and form an adsorbed film. This action is on the border line between a physical and chemical action. There is no adequate proof to definitely classify it.

The function of the adsorbed film lies in the fact that owing to it, the metal rubbing surfaces are no longer in direct contact, but the more mobile oil molecules are on the contact surfaces. These oil molecules are more easily subjected to changes of orientation. The molecules of the adsorbed film are not as mobile as the molecules of the liquid phase. Therefore, in fluid lubrication the friction is due to the shearing apart of the molecules and is less than the friction of the adsorbed film. Friction in the adsorbed film is greater than in the fluid regime, but is much less than that of unlubricated surfaces.

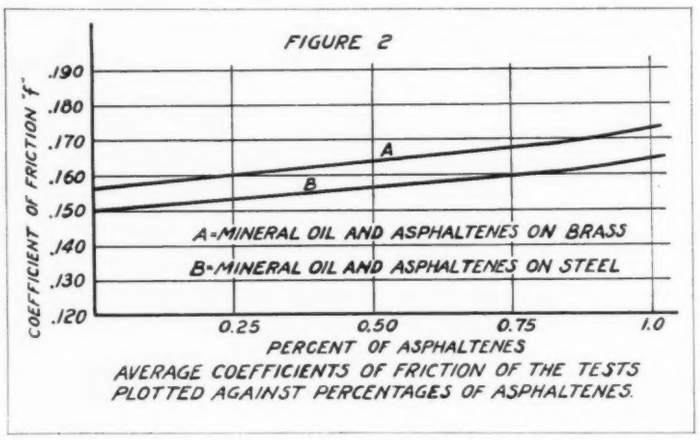
The effect of oiliness is dependent on the manner of the arrangement of the molecules at the interface. The most chemically active part of the molecule is adsorbed or attached to the metal, and the less active part of the molecule extends away from the metal and is free in all relation to it. In this manner a tenacious film is formed over the surfaces, on which the moving part rides, forming a cushion and substituting the friction of the molecules in the film for the friction of the metallic surfaces.

The most tenacious adsorbed film is formed by unsaturates or by chemical compounds of a polar nature, that is, a com-

pound composed of molecules that have a more chemically active group of atoms at one end of the chain and less active atoms at the other end. These molecules tend to arrange themselves in a particular manner. In illustration, take acetic acid, which has a polar group in its composition. This substance with its polar group on one end and less active hydrocarbon group on the other, we may say has dual chemical properties. One part of the molecule may be adsorbed or may react chemically with another compound, while the other end is not affected by this reaction. For example, recall the familiar illustration of oleic acid film on water. When oleic acid is placed on water it acts in the same manner as the acetic acid. The polar end of the molecule is adsorbed or dissolved in the water, while the non-polar end is unaffected. If oil is placed on the surface of the water the non-polar group of molecules are adsorbed or dissolved by it. Here one has two substances that are absolutely neutral to each other, bound together by many bands of molecules extending from one substance to the other. It is apparent that oiliness is influenced by the chemical composition of the molecules which causes such orientation.

According to Archbutt and Deeley, any solid surface may have stray chemical bonds located at points over the surface, the distance apart depending upon the dimensions of the molecules or atoms of the solid. This fact will determine how many molecules may be held per unit area or square centimeter.

The substances that are more readily adsorbed possess the greatest amount of physical-chemical energy, for example, unsaturates, and sulphur and oxygen containing compounds. The adsorbent power of substances in the same series increases with their molecular weights.



Effect of Acids on Oiliness

Acids or acid derivatives that possess the power of orientation lower the coefficient of friction, that is, increase oiliness. The free fatty acids are more effective than their derivatives. Oiliness is influenced very little by the addition of a free fatty acid over a certain amount. As a rule seven-tenths of one per cent of a free fatty acid in an oil will reduce the coefficient of friction to approximately the same coefficient of friction as the acid. Adding an excess of the acid aids very little in lowering the coefficient of friction.

Effect of Asphaltenes on Oiliness

In order to determine what effect asphaltenes that are present in oil (or have been formed during its use), have upon the property of oiliness, the author made the following investigation:

An odorless, colorless, tasteless mineral oil was selected for the oil to be tested because it is a standardized commercial oil, highly refined, and free from any properties that would effect oiliness during the testing on the oiliness machine.

The Herschel oiliness machine was the instrument used to test the property of oiliness. This machine has been constructed to eliminate or greatly diminish the influence of viscosity, by using so low a speed for the test that the coefficient of friction, that measure by which oiliness is judged when there is metal-to-metal contact, will be in maximum value. The greater the oiliness of the oil the smaller the coefficient of friction will be.

Oiliness is very difficult to measure, even on the best developed machines that are now constructed for measuring this property. The difficulty is in preparing the metal surface to a degree of smoothness where the roughness of the surface will not affect the tests. Much time was used in preparing the disc for the tests. Many tests were made to obtain the results. Since it was impossible to obtain exact reproducible results in each case, an average for each was taken from the many trials.

Figure 1 gives the results of the tests of mineral oil on steel and brass. The coefficient of friction is plotted against time to show that a period of time has to be taken to run or wear in the bearing before the machine will give a constant reading. Any reading taken before the surface is run in will be too high and incorrect for the coefficient of friction. The last readings that fall approximately in a straight line on the graph are taken for the correct reading of the coefficient of friction.

The coefficient of friction is smaller for steel than brass. Evidently there was a greater affinity between the mineral oil and steel than the mineral oil and brass, which gave the more tenacious film and aided in descreasing the coefficient of friction. There also was less wear on the steel disc than on the brass disc. This wear was not necessarily because the brass disc was the softer metal, but because the film was less tenacious and there was more metal contact.

In Figure 2 the coefficients of friction are plotted against per cents of asphaltenes in the oil. The coefficient of friction for the brass surface is higher than for the steel surface. This difference is approximately the same as was shown by the mineral oil, being unaffected by the addition of the asphaltenes to the oil. The asphaltenes must have acted as a neutral colloid in the oil phase, the smaller increase of friction being due to the friction of these particles. The above reasoning is substantiated by Figure 2. The property of oiliness has decreased, that is, the coefficient of friction increased very slightly as the percentage of asphaltenes was increased in the mineral oil.

A slight settling out of the asphaltenes showed that asphaltenes dispersed in mineral oil did not make a true colloidal solution. The absence of the resinous substance (its ever-present ally in petroleum oil) seems to leave the asphaltenes without a protective colloid, and they are unable to remain dispersed in the refined mineral oil, as they do in the natural petroleum oils.

The results show that asphaltenes in mineral oil, up to one per cent decrease the property of oiliness to a small degree. However, in practice, using motor oils sold by reputable companies, this may be considered negligible, for from the survey made by the United States Bureau of Standards of samples of different commercial oils that are on the market, the average amount of asphaltenes was only 0.064 of one per cent.

Neely* recently pointed out that in the zone of fluid-film lubrication, viscosity is the only property of the lubricant affecting friction. Under the conditions of boundry or partial-film lubrication the oiliness of the lubricant is of major importance. Differences in oiliness characteristics constitute the essential differences in the lubricating value of oils.

*American Petroleum Institute Meeting, June 3, 1932.

Road Oil Specifications and Refining Methods

By F. R. STALEY

EXTENSIVE experimental work on the application of oil to roads has been carried on during the past year by the United States Bureau of Public Roads and by many of the state highway departments. This work was generally conducted in a scientific manner so that considerable progress has been made. Excellent results have been obtained at low cost on roads which are not subjected to very heavy traffic. Oiled roads are very satisfactory for secondary highway systems. Great mileages of hard surfaced roads are required in many states where the volume of traffic does not justify the expense of concrete paving.

Many refiners have coöperated with highway engineers in order to develop satisfactory road oils and to formulate specifications for various grades. Last October a Road Oil Congress was held in Tulsa, Okla., which was attended by highway officials, engineers and petroleum refiners. The purpose of the conference was to stress the possibilities of road oil which will undoubtedly furnish a large field for petroleum products.

By checking the results obtained with various road oils, and by cooperating with refinery chemists, suitable road oil specifications can be developed so that a satisfactory product can be furnished at a suitable price, and it will not be necessary to meet some unnecessary requirement. Since the oiling of roads is really only in the development period considerable change in the specifications can be expected. In some states the trend is toward lighter oils, while in others the opposite is required, even cut-back asphalts being used.

The specifications of most states require a residue or asphalt content test, either 80 or 100 penetration. Very often tests on the residue are specified, frequently its ductility at two temperatures must be determined. In these specifications that require no residue tests grades 0 and 1 are used as dust palliatives and primers, grade 2 is used for mixing, and grade 3 for surface treatment to be applied hot.

Refining Methods

Road oils are processed from mixed-base or asphalt base crudes. The residuum from these crudes after atmospheric or vacuum distillation can be used. Recently cracking still residuum has been processed to produce specification asphalts. The residue of certain crudes produce superior road oils or asphalt after the light fractions are skimmed off. Very often it is blown while hot in a shell still to make it meet specifications which can be accomplished by oxidation.

The most modern type of unit for distilling asphalt and mixed base crudes is the two-stage vacuum-atmospheric still. The light fractions of the crude are flashed off in the atmospheric tower, and the heavier fractions or lubricating stocks are flashed off in the vacuum tower, while the asphaltic content of the crude concentrates in the residuum which can be made to meet asphalt or road oil specifications.

A 3,500-barrel two-stage distillation unit was recently put into operation in an Eastern refinery to produce specification asphalt. A variety of charging stocks can be used in it, including mixed base crude, heavy asphalt base crude, heavy fuel oil, heavy reduced crude, or cracking still residuum. The products recovered are naphtha, gas oil, and specification asphalt.

In order to produce salable asphalt and road oils from cracking unit residuum a vacuum flash system has been developed. No heater is required. The hot residuum is flashed in a vacuum tower where the light fractions are vaporized overhead, and the gas oil is stripped from the bottoms by steam. Since cracking capacities have increased so greatly during the past year for the production of high octane gasoline the quantity of asphalt and road oils produced from cracking plant residuum will no doubt expand.

The most important research problems in connection with road oil are the ductility of the residue and its life. Penetration of the bitumen into mineral aggregate and the displacing effect of water are also important problems for study. Emulsions used for roads are of interest to chemists and engineers at the present time. The problem is to make the emulsion of the desired stability and penetrating power.

THIS MONTH'S COVER

Through the courtesy of L. A. Cranson, secretary, Honolulu Oil Corporation, Ltd., San Francisco, Calif., we reproduce on our front cover this month an air view of a portion of the Rincon oil field, Ventura County, California. In the foreground the foundation of Seacliff Development Company's well No. 1 is under construction and is made accessible by the pier of the General Petroleum Corporation, owners of the two completed wells alongside.

Testing Methods

Most of the laboratory tests used in connection with road oils and asphalts are A. S. T. M. standards. They include determination of bitumen, ductility, penetration, viscosity (Saybolt Furol or Engler), float test, asphalt content and some others.

The ductility of an asphalt or semi-solid bitumen is measured by the distance to which it will elongate before breaking when two ends of a briquet of the material are pulled apart at a specified rate of speed and at a specified temperature, which for a normal test shall be five cm. per minute at 25 degrees C. (77 degrees F.). The A. S. T. M. designation for the tentative method of test for ductility of bituminous materials is D113-26T.

According to this method a standard briquet mold is used for the sample. The water bath must be maintained at a temperature not varying more than 0.1 degrees C. from 25 degrees C. (77 degrees F.). The volume of water shall be not less than 10 liters and the sample shall be immersed to a depth of not less than 10 cm. and shall be supported on a perforated shelf not less than five cm. from the bottom of the bath.

Any apparatus may be used for pulling the briquet of bitumen apart that is so constructed that the briquet will be continuously immersed in water and the two clips pulled apart at a uniform rate of speed at 5 cm. per minute.

Procedure

The bituminous material to be tested shall be completely melted at such a temperature that it will be thoroughly fluid

REPRESENTATIVE STATE SPECIFICATIONS FOR ROAD OILS, 1932

Explanation of Abbreviations: Penet.—Penetration; S.F.—Saybolt Furol; P.M.—Pensky-Martin; C.C.—Cleveland Open Cup; E—Engler; O.C.—Open Cup; Min.—Minimum; Max—Maximum; Sol.—Soluble.

State	Designation	Use	Specific Gravity	Residue Content "Asphalt Content"	Solubility	Viscosity	Flash	Water and Sediment	Evaporation Loss	Ductility of Residue	Distillation Test	Float Test	Other Tests and Requirements
Arizona—1930	.....	Gravel or C Rock	.....	<60% of 80 penet.	99% in CS_2	Not above 250 S.F. @120°F.	Not below 190°F. P.M.	Not over 2%	.....	.....	.....	.....	Bitumen solution in CS_2 shall be 99.96% soluble in CCl_4.
California 1931	Asphaltic Road Oil	.....	.....	<94% of 80 penet. D 243-26 T.	99 0% sol in CS_2	.....	.....	0.5% or less H_2O 1% or less sedim	.....	<1 cm @ 34-35°C D 113-23 T	.....	.....	Must not be blended product. Bitumen sol. in CS_2 shall be 99.65% sol. in CCl_4. Asphaltenes 6-27%.
	Fuel Oil—Light	.....	.....	50-60% of 80 penet.	99% sol. in CS_2 Bitumen 99.65% in CCl_4	40-80 S.F. @ 122°F.	<175°F.-P.M.	Not over 2%	.....	.....	.....	.....	It is assumed this product is used as road oil.
	Fuel Oil—Heavy	.....	.....	60-70% of 80 penet.	.....	220-300 S.F. @ 122°F.	<225°F.-P.M.	Not over 2%	.....	.....	.....	.....	It is assumed this product is used as road oil.
Colorado 1932	65-75 Asphaltic Road Oil	.....	.....	65-75% of 80 penet.	.....	300-600 @ 122°F.	<200°F.-C.C.	>2%	.....	<6 cm @ 40-41°F. <80 cm @ 77°F.	.....	.....	Shall be product from asphalt base oil and shall contain not more than 2% paraffin wax.
Connecticut 1932	No. 3-45% Asphaltic Road Oil	.....	Not below .920 @ 25°C.	45 to 55% of 100 penet.	99.96% in CS_2	100 to 150 S.F. @ 25°C.	Not below 55°C. Open Cup	Free from water and homogeneous	15 to 30% 5 hrs. @ 163°C.	.....	.....	.....	.....
	No. 4-65% Asphaltic Road Oil	.....	Not below .95 @ 25°C.	60 to 70% of 100 penet.	99.9% in CS_2	150 to 300 S.F. @ 50°C.	Not below 55°C. Open Cup	Free from water	10 to 25% 5 hrs. @ 163°C.	.....	.....	.....	.....
Indiana 1931	Road Oil A-50	Gravel, stone, dust pallative, mat	<.950 @ 77	50-65	99% sol. in CS_2	5-30 E. @ 122°F.	<79.4°C.-O.C.	>1%	20% @ 325°F-5 hrs.	50 cm @ 77°F.	I.B.P.<446°F. 599°F.<50% 698°F.>85% % 100 penet. Residue>15	.....	
	Road Oil A-60	Gravel, stone, dust pallative mat	<.960 @ 77	60-75	99% sol. in CS_2	10-45 E. @ 122°F.	79.4°C.-O.C.	.....	15% @ 325°F-5 hrs.	50 cm @ 77°F.		.....	
	Road Oil A-70	Gravel, stone, dust pallative, mat	<0.960 @ 2.7	70-85	99% sol. in CS_2	10-45 E. @ 140°F.	79.4°C.-O.C.	.....	12% @ 325°F-5 hrs.	50cm @ 77°F.		.....	
	Road Oil O. C.-2	Stone and gravel for mat	0.935-1.030 @ 77°F.	.....	99% sol. in CS_2	80-120 E. @ 77°F.	80-200°F.-O.C.	No water	15-30% @ 325°F. for 5 hrs.	.....		.....	Flood test of residue @ 122°F. (New Resid. 90 Min. —Oil Asphalt 130 Min. Vis. Engler (first 50 C. C.) @ 77°F. 5-16.
	Non-Asphaltic Road Oil	.....	>0.950	.....	.....	5-16 E. @ 77°F.	<248°F.	>2% H_2O	.....	.....		.....	
Kansas 1931	AO-0	Low temperature or dense subgrade	0.980 Min. @ 25°C	55% Min. 100 penet.	99% sol. in CS_2 asphaltenes-8% Min.	40-100 S.F. @ 122°F.	100°C. Min.	2% Max.	10% Max. @ 163°C. 5 hrs.	100 Min. @ 25°C.	.....	.....	**Penetration** of distillation residue 25C. 100 gm, 5 Sec: ACC, 80-110; ACP, 60-110; ACM, 70-110; ACH, 60-110. **Distillation:** Up to 225°C 10%; up to 315.5°C 30% Min.; to 360°C, 40% Max. **Distillation:** Up to 225°C 10%; up to 315.5°C 25% Min.; to 360°C, 38% Max. **Distillation:** Up to 225°C 10%; up to 315.5°C 20% Min.; to 360°C, 35% Max. **Distillation:** Up to 225°C 5%; up to 315.5°C 15% Min.; to 360°C, 30% Max. **Distillation: residue** 99% soluble in CS_2 for all products.
	AO-1	Penet. treatment, except where AO-0 is spec.	0.980 Min. @ 25°C.	65% Min. 100 penet.	99% sol. in CS_2 asphaltenes—13% Min.	150-300 S.F. @ 122°F.	100°C. Min.	2% Max.	8% Max. @ 163°C. 5 hrs.	100 Min. @ 25°C.	.....	.....	
	AO-2	Bituminous mat.	0.980 Min. @ 25°C.	75% Min. 100 penet.	99% sol. in CS_2 asphaltenes—15% Min.	350-500 S.F. @ 122°F.	100°C. Min.	2% Max.	8% Max. @ 163°C. 5 hrs.	100 Min. @ 25°C.	.....	.....	
	AO for plant mix	1 plant mixing	0.980 Min. @ 25°C.	75% Min. 100 penet.	99% sol. in CS_2 asphaltenes—15% Min.	600-900 S.F. @ 122°F.	100°C Min.	2% Max.	8% Max. @ 163°C. 5 hrs.	100 Min. @ 25°C.	.....	.....	
Michigan 1932	OADP	.....	.900 Min. 25°C.	.....	99.5% sol. in CS_2	E-50 C.C.-25°C 50-30	80°C. Min. O.C.	.....	30% Max. 163°C. 5 hrs.	Residue from dist'n @ 25°C.	.....	.....	
	OAC	.....	0.935-0.970	.....	Asphaltenes 6% Min. 99.5% sol. in CS_2	E-50 C.C.-25°C 80-120	50°C. Max.	.....	30% Max. 163°C. 5 hrs.	.....	90 Min. @ 50°C. on Residue from E.L.	Res. @ 50°C. 90 Min.	
	ACC	.....	.....	.....	.....	E-50 C.C.-25°C. 40-80	26.7°C. Min.	.....	.....	60	.....	.....	
	ACP	.....	.....	.....	.....	E-50 C.C.-50°C. 15-30	26.7°C. Min.	.....	.....	60	.....	.....	
	ACM	.....	.....	.....	.....	E-50 C.C.-50°C. 50-100	26.7°C. Min.	.....	.....	60	.....	.....	
	ACH	.....	.....	.....	.....	E-50 C.C.-50°C. 150-200	26.7°C. Min.	.....	.....	60	.....	.....	
	OAH	.....	0.960 Min. 25°C.	.....	Asphaltenes 6% Min. 99% sol. in CS_2	E-50 C.C.-160°C. 60 Max.	80°C. Min.	.....	15% Max. 163°C. 5 hrs.	.....	.....	32°C.-60 Max. Res. @ 50% 110 Min.	
New York 1932	Hot Application	.....	0.92 Min. @ 77	60-70% of 100 penet.	99.5% in CS_2	.....	.....	Free from H_2O	22-28 @ 325°F.	25 cm Min. @ 77°F.	.....	.....	Fixed carbon 5-12%. Paraffin wax 4% Max.
	Cold Application	.....	0.90 Min. @ 77	45-55% of 100 penet.	99.5% in CS_2	.....	.....	Free from H_2O	20-35% @ 325°F.	25 cm Min. @ 77°F.	.....	.....	Fixed carbon 4-8%. Paraffin wax 4% Max.
North Dakota	.....	Road Mix	.....	63% Min. of 80 penet.	99% Min. CS_2 Bit. in CCl_4 99.65%	300 Max. S.F. @ 122°F.	225°F. Min. P.M.	H_2O O. S. Max. W+S-2.0 Max.	325°F.-5 hrs. 6% Max.	8 cm Min. @ 39.2°F.	.....	.....	Ductility of evap. residue @ 77°F-100 Min.
	B	Shoulder treatment	0.975 Min. @ 77	60% Min. of 100 penet.	99% sol. in CS_2. Asphaltenes-9% Min.	183 Max. S.F. @ 122°F.	194°F. Min.	Free from H_2O	325°F.-5 hrs. 8% Max.	100 cm. Min @ 77°F.	.....	.....	.....
	M	Plant Mix	.....	70% Min. of 80 penet.	99% sol. in CS_2. Min. 99.65% sol. in CCl_4 Min.	1200 S.F. @ 122°F Max.	225°F. Min. P.M.	H_2O-0.5 Max. W+S-2.0 Max.	163°C.-5 hrs. 6% Max.	8 cm Min. @ 40°C 100 cm Min.: 25°C	.....	.....	.....

	Heavy	Hot surface treat.	0.980 Min. @ 77	85% Min. of 100 penet.	99.5% Min. in CS_2 Asphaltenes - 15% Min.	.....	94°C. Min.	Free from H_2O	163°C.-5 hrs. 10% Max.	.....	.....	.....	.....
Massachusetts 1930	Light	Cold surface treat.	0.890-.960 @ 77	30-35% 100 penet.	99.5% in CS_2 Min. Asphaltenes 3% Min.	E 12 Max. @ 77	80°C. Min.	Free from H_2O	163°C.-5 hrs. 42% Max.	.....	.....	.....	.....
	Medium	Cold surface treat.	0.92-.970	45-55% 100 penet.	99.5% in CS_2 Min. Asphaltenes 60% Min.	E 30-65 @ 77°F.	50°C. Min.	Free from H_2O	163°C.-5 hrs. 30% Max.	.....	.....	.....	.....
Ohio 1932	Road Oil	Hot Application	.980 Min. @ 25°C.	.....	99.5% sol. in CS_2 Min.	.....	.....	Free from H_2O	163°C.-5 hrs. 7% Max.	.....	.....	100-150 @ 50°C.	Fixed carbon 9% Mln.
Pennsylvania 1932	Road Oil	Earth Roads	.....	30-40% 100 penet.	99% sol. in CS_2 Min. Asphaltenes 4% Min.	25-65 S.F. @ 25°C	55°C. Min. O.C.	Free from H_2O	163°C.-5 hrs. 15-35%	.....	.....	.....	.....
	Asphaltic Oils	Light surface—cold	.....	45-55% 100 penet.	99% sol. in CS_2 Min.	100-200 S.F. @ 77°F.	50°C. Min. O.C.	1.0% Max.	15-30% @ 163°C. 5 hrs.	50 cm Min. @ 77°F.	.....	On 100 penet. residue 20 Min. @ 32°C.	.....
Rhode Island 1931	Asphaltic Oils	Medium	.....	60-70% 100 penet.	99% sol. in CS_2 Min.	120-240 S.F. @ 77°F.	50°C. Min. O.C.	No water	10-20% @ 163°C. 5 hrs.	50 cm Min. @ 77°F.	.....	On 100 penet. residue 20 Min. @ 32°C.	.....
	Asphaltic Oils	Heavy—Hot application	.....	85-95% 100 penet.	99% sol. in CS_2 Min.	.....	163°C.-O.C.	No water	10% Max. @ 163°C.-5 hrs.	50 cm Min. @ 77°F.	.....	90-175 @ 50°C. 100 penet. res. @ 50°C.-125.	Float on residue of 100 penet. Min. 125.
	Cut Back Asphalt	.....	.....	.....	99% sol. CCl_4	1-10-20 Engler 2-20-30 50 C.C. 3-40-60 @ 122°F.	347°F.-O.C.	.....	163°C.-50 gms. 5 hrs. 2%	30 cm @ 77°F	.....	.....	Three grades made by fluxing 150-200 penet. asphalt (77°F. 100 gms., 5 sec.) with heavy naphtha.
South Carolina	Cut Back Asphalt	.....	.....	.....	99% sol. CCl_4	1-10-20 Engler 2-20-30 50 C.C. 3-40-60 @ 122°F.	347°F.-O.C.	.....	.....	.....	.....	.....	Three grades made by fluxing 85-100 penet. asphalt with heavy naphtha.
	No. 1	.....	.960 Min. @ 77	60% Min. of 100 penet.	99.65% sol. in CCl_4 Min.	100-200 S.F. @ 122°F.	150°F. Min.	Water and sed. 2% Max.	8% Max., 325°F. 5 hrs.	on residue 100 cm Min. @ 77°F.	.....	.....	.....
	No. 2	.....	.960 Min. @ 77	65% Min. of 100 penet.	99.65% sol. in CCl_4 Min.	200-350 S.F. @ 122°F.	220°F. Min.	Water and Sed. 2% Max.	6% Max., 325°F. 5 hrs.	On 100 penet. res. 100 cm Min. @ 77°F. 6 cm Min. @ 39.2°F.	.....	.....	.....
South Dakota	No. 3	.....	.960 @ 77°F.	75% Min. of 100 penet.	99.65% sol. in CCl_4	600-1200 S. F. @ 122°F.	300°F. Min.	Water and Sed. 2% Max.	4% Max., 325°F. 5 hrs.	On 100 penet. res. 100 cm Min. @ 77°F. 6 cm Min. @ 39.2°F.	.....	.....	.....
	Cut Back Asphalt	.....	.....	.....	.....	Light 160-320 S. F. @ 77°F. Med. 200-400 S.F. @ 122°F. Heavy 600-800 S.F. @ 122°F.	.....	.....	.....	.....	.....	.....	Shall be made from base suitable for paving. Residue after dist'n to 680°F—Light 80-100 penet., Medium 70-110, heavy 60-110.
Texas	R O 1	.....	0.95 Min. @ 77	55-70% 100 penet.	99.5% CS_2 Min.	25-40 @ 122°F. Sp. Vis. Engler	175°F. Min.	H_2O + Sed. 1% Max.	1-2% 5 hrs. 212°F.	.....	.....	.....	.....
	R O—3	Old Mix Surface Treat.	0.55 Min. @ 77	65-80% 100 penet.	99.5% CS_2 Min.	100-160 @ 122°F Sp. Vis. Engler	225°F. Min.	H_2O + Sed. 1% Max.	0.6% 212°F.	.....	.....	.....	.....
	65 Grade	.....	.....	65% Min. 100 penet.	.....	400 Max. S.F. @ 122°F.	220°F. Min.	H_2O + Sed. 2% Max.	9% Max. 325°F. 5 hrs.	.....	.....	.....	.....
Wyoming	70 Grade	.....	.....	70% Min. 100 penet.	.....	900 Max. S.F. @ 122°F.	240°F. Min.	2% Max.	7% Max. 325°F. 5 hrs.	.....	.....	.....	.....
	0	.....	.....	30-35% 80 penet.	99% Min.	30-40 S.F. @ 77°F	150°F. Min. P.M.	H_2O + Sed. 2% Max.	..... Max. 2%	.....	.....	.....	Sol. in CCl_4 99.65%.
	1	.....	.....	50% Min. 80 penet.	99% Min.	40-80 S.F. @ 122°F.	175°F. Min. P.M.	H_2O + Sed. 2% Max.	..... Max. 2%	.....	.....	.....	Sol. in CCl_4 99.65%.
Oregon	2	.....	.....	65% Min. 80 penet.	99% Min.	200-300 S.F. @ 122°F.	225°F. Min. P.M.	H_2O + Sed. 2% Max.	..... Max. 2%	.....	.....	.....	Sol. in CCl_4 99.65%.
	3	.....	.....	95% Min. 80 penet.	99% Min.	.....	395°F. Min. P.M.	H O — 1/2% Sed. — 1% Wax — 2%	.....	.....	.....	250 Sec. Min. @ 122°F.	..... Sol. in CCl_4 99.65%.
New Mexico (11A)	65-70 Road Oil	.....	.....	65-70% 100 penet.	.....	Specific E-40-100 @ 122°F.	190°F. Min. O.C.	H_2O + Sed. 2% Max.	.....	.....	.....	.....	Paraffin not more than 2%. Carbines in Res., 5% Max.
	70-80 Road Oil	.....	.....	70-80% 100 penet.	.....	Specific E-120-200 @ 122°F.	245°F. Min. O.C.	H_2O + Sed. 2% Max.	.....	.....	.....	.....	Paraffin not more than 2%. Carbenes in Residue, 5% Max.
Florida	Asphaltic Oil	"Mixed-in-place" sand asphalt road	.....	68% Min. 100 penet.	99.5% Min. CS_2 15% Min. Insol. in 86 deg. Naphtha	18-30 1st 50° C. Sp. Vis. Engler	.....	.....	.....	.....	5-10% @ 150°C. 20-29% @ 200°C. 32 Max. @ 205°C.	.....	Base asphalt 85-100 penetration at 77°F. before cutting back with naphtha. 200 Max. penetration at 77°F. on residue from 325°F loss.

—with ordinary paving asphalt cement this is about 160 degrees C. (320 degrees F.). It shall then be strained through a 50-mesh sieve and, after a thorough stirring, poured into the mold. The mold shall be assembled on a brass plate and so as to prevent the material under test from sticking, the surface of the plate and the interior surfaces of the side pieces of the mold shall be thoroughly amalgamated. In filling the mold care shall be taken not to disarrange the parts and thus distort the briquet. In filling, the material shall be poured in a thin stream back and forth from end to end of the mold until it is more than level full. It shall be left to cool to room temperature and then placed in water maintained at 25 degrees C. (77 degrees F.) for 30 minutes, after which the excess of bitumen shall be cut off by means of a hot putty knife or spatula so that the mold shall be just level full.

The brass plate and mold, with briquet, shall then be placed in the water bath and kept at a temperature of 25 degrees C. (77 degrees F.) for a least one and one-half hours, when the briquet shall be removed from the plate and the side pieces detached.

The rings at each end of the clip shall then be attached to the pins or hooks in the ductility machine and the two clips pulled apart at a uniform rate of 5 cm. per minute until the briquet ruptures. The distance through which the clips have been pulled to produce rupture shall then be measured in centimeters. While the test is being made, the water in the tank of the ductility machine shall cover the sample by at least 2.5 cm. and shall be kept continuously at a temperature within 0.5 degrees C. of 25 degrees C. (77 degrees F.).

A normal test is one in which the material between the two clips pulls out to a point or thread until rupture occurs at the point where the thread has practically no cross-sectional area. The average of three normal tests shall be taken and reported as the ductility of the sample.

If a normal test is not obtainable on three successive tests, the ductility should be reported as being unobtainable under the conditions of the test.

Penetration is defined as the consistency of a bituminous material, expressed as the distance that a standard needle vertically penetrates a sample of the material under known conditions of loading, time and temperature. Where the conditions of test are not specifically mentioned, the load, time and temperature are understood to be 100 g., 5 seconds, 25 degrees C. (77 degrees F.), respectively, and the units of penetration to indicate hundredths of a centimeter.

In making the test the sample is placed in the transfer dish filled with water from the water bath of sufficient depth to completely cover the container. The transfer dish containing the sample shall then be placed upon the stand of the penetration machine. The needle loaded with specified weight, shall be adjusted to make contact with the surface of the sample. This may be accomplished by making contact of the actual needle point with its image reflected by the surface of the sample from a properly placed source of light. Either the reading of the dial shall then be noted or the needle brought to zero. The needle released for the specified period of time, after which the penetration machine shall be adjusted to measure the distance penetrated.

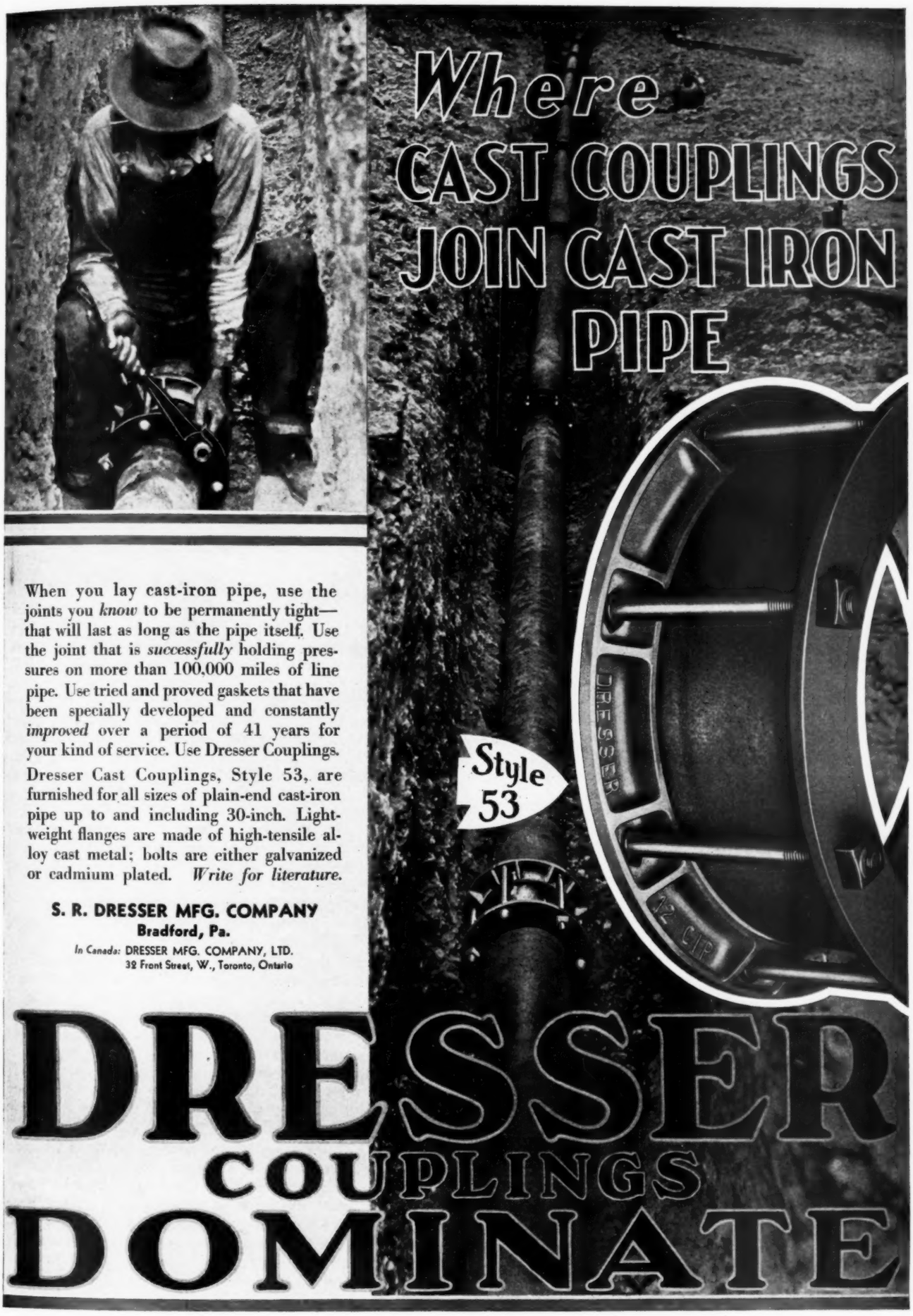
At least three tests shall be made at points on the surface of the sample not less than 1 cm. (3/8 inch) from the side of the container and not less than 1 cm. (3/8 inch) apart. After each test the sample and transfer dish shall be returned to the water bath and the needle shall be carefully wiped toward its point with a clean, dry cloth to remove all adhering bitumen. The reported penetration shall be the average of at least three tests whose values shall not differ more than four points between maximum and minimum. The A. S. T. M. designation is D5-25.

The A. S. T. M. designation for the standard method of test for the determination of bitumen is D4-27. The total bitumen is the weight of the sample taken minus the total weight of the matter insoluble in carbon disulphide.

The multiple life type of bituminous surfacing originated in the Northwest and consists of alternate layers of bitumen and aggregate. Maintenance of oiled roads is important. Many projects reported as failures would have been successful if properly maintained.

Refiners cannot afford to overlook the fact that oiled roads are becoming increasingly important in the economic scheme of hard surfaced highways, and it will be to their advantage to coöperate with the highway departments to develop road oils that will give the best results at minimum cost, and at the same time they can develop a large potential market for petroleum products.

Flash Jug for fractionating cracking plant residuum into gas oil overhead and asphalt bottom. The tower is equipped with condenser for the overhead vapor, vacuum run down tank, barometric condenser for steam and steam jet air pumps for removing non-condensable vapor.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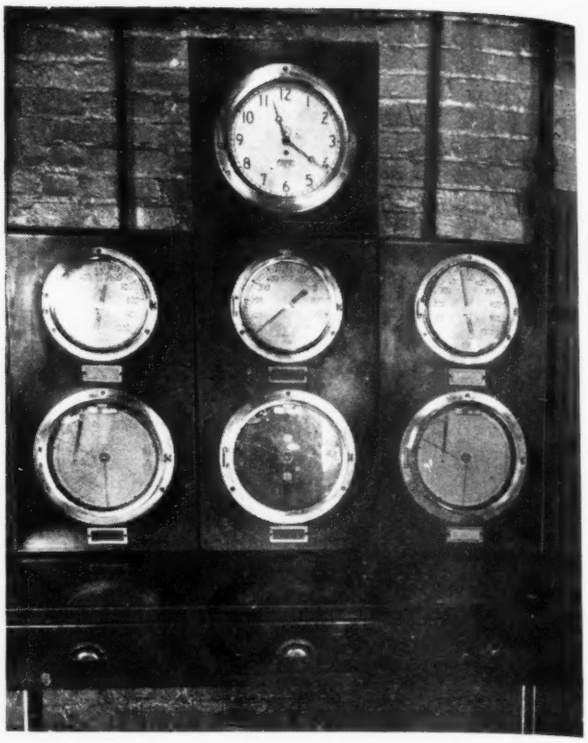
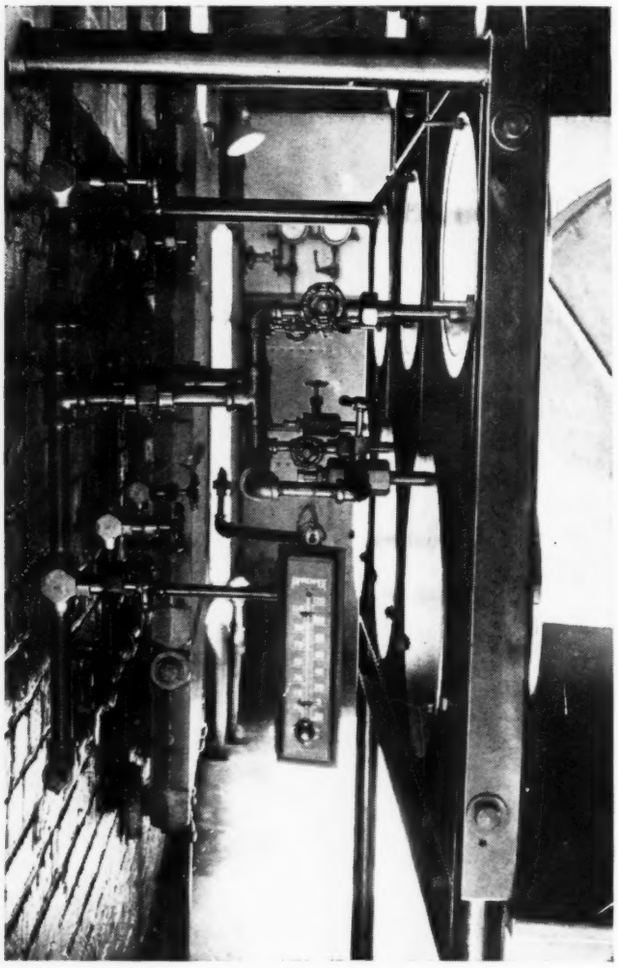
Instrument Board Design Is Efficiency Factor in Station Operation

THE efficiency of a gas line compressor station, or the main line stations of an oil transportation system, usually representing a large investment, is greatly influenced by the instrument board controlling its operation. Many stations have been built containing machinery costing hundreds of thousands of dollars, but for economy's sake, an inexpensive board may be installed. In many cases old gauges that have been in service for years are salvaged and used. Frequently such instruments are inaccurate and then the board is so designed that it is necessary to shut off the gauge lines and remove the instrument for a test.

Within the past few years, pipe line companies have been devoting more attention to the design of instrument boards and the purchase of equipment. These companies formerly made periodical tests of their gauges and, when necessary, the gauge was removed and sent to the company shop for repair. This frequently involved considerable expense.



Front view of unit system board



Rear view of system board

The Oklahoma Pipe Line Company, Muskogee, Okla., is one of the companies that design instrument boards with the view of improving their service. Such an installation is located at the company's Glenn Pool, Oklahoma, station.

It is a unit system board which will permit adding new panels or removing any of the existing panels. All piping is so manifolded as to permit the cutting in or out of any one panel without disturbing the others.

Each panel is equipped with both an indicating and recording gauge and the board now in use contains three panels. Two of these are in constant service and the third is used as a stand-by installation. Whenever a test is desired, the instruments on the panel are isolated and the test made. Should the test reveal the necessity of an adjustment or repair, the gauge is removed and the stand-by panel used until the gauge has been repaired. No local repairs are made.

The board is set a sufficient distance from the side wall to permit station engineers to reach all connections and valves with comparative ease. All piping is half inch, and all of the gauge lines are manifolded to the pressure lines. While the manifold appears somewhat complicated in comparison to standard gauge board installations it is so spaced that connections may be made or broken with little or no trouble. The board is amply braced to make the connections more rigid. Considerable space was conserved by using stainless steel needle valves, which also give close regulation.

Because of the space provided, the back of the board is easily kept clean. The board front consists of the manufactured panels and the desk upon which the station operators prepare and record their reports.

While this type of gauge board construction represents a higher first cost than types formerly used, its use is proving more economical in the long run. During its period of operation the service of this installation has been highly satisfactory.

Metering Crude Oil

By K. C. SCLATER

RECENTLY the Railroad Commission of the State of Texas issued orders to transporters of oil requiring that all pipe lines carrying oil from the East Texas field be equipped with oil meters. This order included main pipe lines and auxiliary lines to loading racks, refineries and stock tanks. It is stipulated in the order that no by-pass be installed around the meter. Naturally, issuance of the order has aroused increased interest in the metering of crude oil, especially in view of the fact that the accuracy tolerance as set forth in the order is held to 2 per cent plus or minus; that is, the limit of meter error should not fall without the range of 98 and 102 per cent.

Compared with the metering of water, the accurate metering of crude oil is a comparatively difficult problem. Water is a homogeneous liquid, and, under ordinary pressures and temperatures, offers no serious difficulties such as are encountered in the quantity measurement of crude oil. Crude oil is a complex mixture of hydrocarbons and its physical properties therefore are quite different from those of a simple homogeneous liquid. Even among crude oils there are vast differences in their chemical and physical character and no two crudes are exactly alike. Crudes produced from the same field but from different horizons in that field may differ vastly in chemical and physical character, hence under changes of temperature and pressure will exhibit varying physical properties.

The recent ruling of the Texas Railroad Commission stipulating that meters be placed on all lines transporting oil from the East Texas field constitutes a new step in oil transportation practice.

Since this new ruling may exert a broad influence in future pipe line operations, especially in flush fields, *The Petroleum Engineer* presents to its readers five consecutive timely and authoritative articles dealing with various phases of metering oil in pipe lines.—*Editor.*

When crude oil is produced from the well and placed in the lease tanks it usually contains some gas in solution, and probably some of the lighter hydrocarbons that are unstable under ordinary pressures and temperatures. Gas in solution in the crude may be in the liquid or in the gaseous phase, depending on the pressure, temperature and the producing conditions in the well. Its presence not only may give a high liquid reading when passing through the meter, but it may also, if there is any appreciable reduction in pressure after the fluid passes through the meter, cause excessive shrinkage. The amount of this shrinkage can easily be greater than the limits of error allowed in the meter. This is especially likely to occur in the case of oil produced from the East Texas field.

Oil from this field has natural gas in solution, a large proportion of which is composed of the heavier gasoline constituents. Near atmospheric temperature and pressure these are unstable, hence a slight change in pressure or temperature may change them from the liquid to the gaseous phase and may cause their release from solution. This would cause a considerable change in the volume of the crude because the heavier the molecular components of the gas liberated from solution the greater the shrinkage.

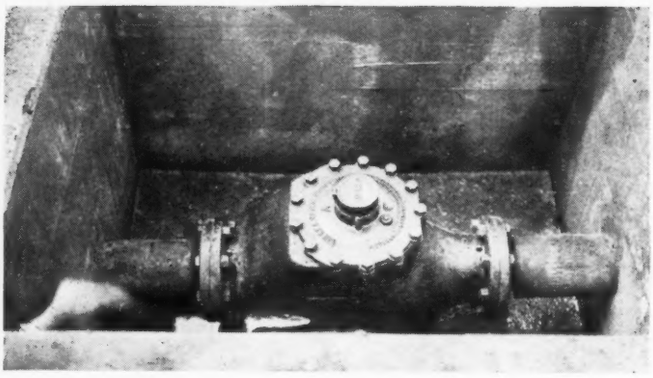
In addition to gas in solution there is likely to be small amounts of sand, silt or other gritty impurities in suspension that will be detrimental to the metering equipment by causing excessive wear and tear unless some provision is made to remove these impurities or effectively combat the conditions that they set up. Water may also be present, the effect of which may be to change the physical character of the crude itself. However, as the pipe line requirements for water and B. S. are strictly limited to very small percentages, metering accuracy is not likely to be affected to any appreciable extent by the presence of water in the crude.

The method by which a well is produced will influence the amount of gas in solution in the oil when it reaches the lease tank. Insufficient separation, or producing a well at high rates of flow may cause variable volumes of gas to be held in solution in the oil even when it reaches the lease tank, and when this oil is pumped to permanent storage the agitation resulting will tend to liberate the gases held in solution. Thus, when the crude passes through the meter a false reading may result as to the actual quantity of liquid that has been passed. This difficulty is the principal reason why the accurate metering of crude oil from wells before the oil is run to lease storage has not been found altogether practicable. Complete absence of free gas in the liquid seems to be an essential requirement for the accurate metering of crude oil in practical field operations.

It is still universal practice to gauge crude oil in tanks, consequently all pipe line runs are checked by this method. Where meters are installed, meter readings are checked against the tank gauges. From a consideration of the varied nature of natural gases and their effect on the volume of crude oil, when liberated from solution under relatively small changes of pressure and temperature, it would seem that, to get a thorough check on meter readings, rather than depend solely on tank gauges, it might be necessary to run analyses of the crude both before and after passing through the meter. That is, run check analyses on the crude in the working tank and in the receiving tank. In this way the effect of shrinkage caused by some of the heavier gases being released from solution could be observed and due allowance made. But to assume that, should the amount of crude pumped into the receiving tank be less than that pumped from the working tank, it is due to inaccurate gauging, would be seriously in error. If progress in the metering of crude oil is to be made, the effects of the various constituents of natural gas in solution in crude oil on their liberation from solution should be observed and the necessary correction made for shrinkage.

Another factor that is worthy of investigation in considering the possible accuracy with which crude oil can be metered is the rate of release of the various components of the natural gas from solution. In regard to oil in lease tanks the volume and composition of gas in solution are dependent on several factors.

East Texas crude has certain characteristics that make its accurate quantity measurement difficult. The fact that it contains proportionately large amounts of the heavier molecular components of natural gas means, of course, that much of it will come out of solution at comparatively low pressures. Also the rate of release of the gases from solution will



A 6-inch liquid meter of the current or velocity type installed on a main pipe line in Oklahoma.

be slow and depend to a large extent on how the oil is handled before it is run to the lease storage tank. In other words, the method of producing the well will be an important factor influencing the release of gas from solution. If the oil has been subjected to considerable agitation and is passed through an efficient trapping system there may not be enough gas left in solution to seriously affect the accuracy of the meter.

The rate at which the well is produced may enter as an important factor. If the well is produced at a slow rate so that it makes its allowable production over a 24-hour period there will be ample opportunity for most of the gas to be released from solution. On the other hand, if the well is produced at a high rate so as to obtain its daily allowable production in a few hours, much of the gas will be held in solution unless an exceedingly efficient gas-oil separation system is used.

In the East Texas field it is believed that there is, in many cases, incomplete separation of the oil and gas by the time it reaches the lease tank. Complete separation, however, is not always desired. Field storage tanks are now made vapor-tight and it is frequently found to be advantageous to maintain the gravity of the crude.

While a simple relationship exists between the fundamental quantities involved in metering fluids, it is difficult to measure crude oil accurately because of the difficulty of making the necessary corrections for appreciably viscous and expansible fluids. Crude oil is properly considered as a partly gaseous fluid and as such is subject to the effect of expansion. Discontinuity of flow and absolute pressure affect the fluid stream in the pipe and hence may affect its measurement. If the pressure is changing the fluid may not fill the pipe and if there is any gas in solution it may come out while the crude oil is being pumped. It is also important to note that with many grades of crude the changes in velocity distribution in the stream-line flow, will be quite severe for relatively small changes of temperature.

It is interesting to note that although the viscosity of gases increases with an increase of absolute temperature, the viscosity of crude oil will generally decrease with an increase of temperature. This is attributed to the fact that the molecules of the gas being more widely separated less interchange of momentum between the molecules occurs.

While viscosity is considered to be practically independent of pressure for a homogeneous liquid, it is not exactly true of crude oil, which is a mixture of hydrocarbons each differing slightly in chemical and physical properties.

Meters for the measurement of liquids may be conveniently classified as follows: orifice meters, displacement meters and current, impulse-wheel or velocity meters. Of the orifice meters, the thin plate type, the venturi type and the nozzle type are most common, while of the displacement meters, the disc type, the rotary type and the piston type are well known.

There are also refined forms of the Pitot tube that have been successfully used for water measurement in pipes.

For the measurement of crude oil in trunk pipe lines the venturi meter is in successful use and meters quantities and rates of flow well within the desired range of accuracy.

A well designed positive displacement piston type meter has also been in successful use for several years for the accurate quantity measurement of refined oils. This meter has also had a limited application in California fields on measuring the quantities of crude oil produced by wells. Where it has been used for oil field service of this nature special provisions have had to be made to prevent free gas—liberated from solution in the oil—from passing through the meter. This meter has a compensating device for temperature changes of the liquid. On refined oils this meter is accurate to within less than 1 per cent.

Interesting tests that may be far-reaching in their results are under way in Oklahoma. Crude oil measurements are being made with an approved type of velocity meter specially adapted to crude oil pipe line service. The meter is installed on a main pipe line about 30 miles from the pumping station. It is interesting to note in connection with this installation that the pumps are of the reciprocating type. The pressure at the metering point is from 50 to 100 pounds.

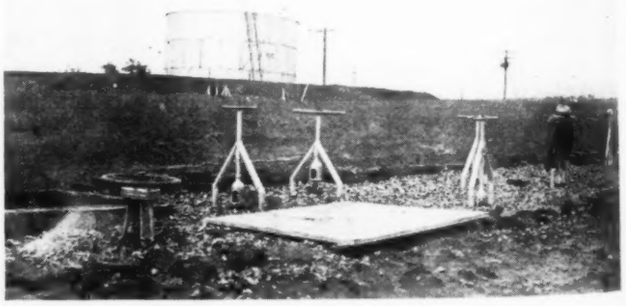
Some interesting data on the accuracy of this type of meter are being gathered.

Pumping oil at the average rate of 23,000 barrels daily, the total variation between the working tank gauges and meter readings, over a period of 23 days, was less than 0.004 per cent. Compared with the daily tank gauges the meter showed an average of 0.898 slow, and 0.646 fast. These averages were taken over the 23-day period.

Over a period of 12 hours, during which more than 2,000 barrels of oil passed through the meter, the variation between the meter and the receiving tank gauge was 0.568 per cent, or a total difference of less than 12 barrels.

This oil was about 39 degrees gravity A.P.I. and was being pumped from storage tanks near the field.

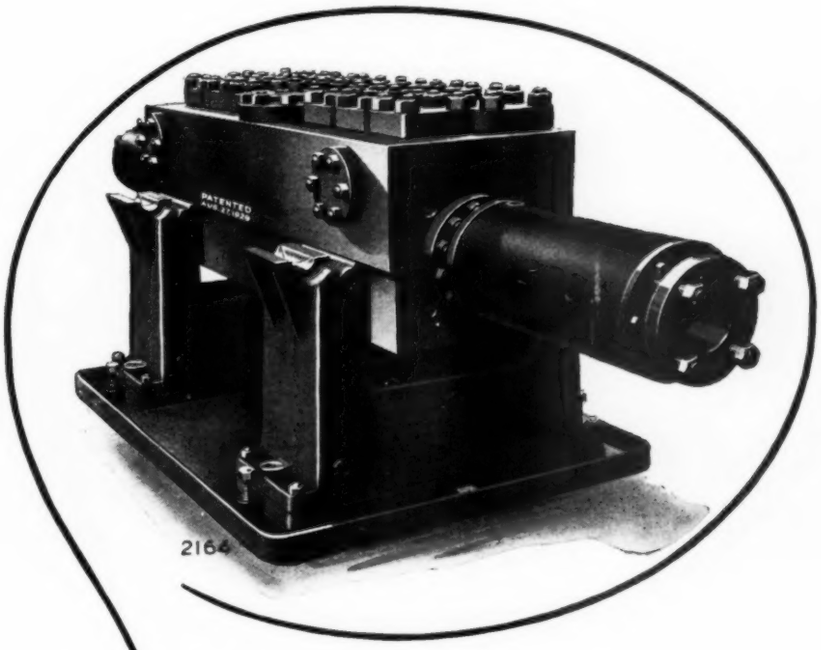
With this remarkably close accuracy, which is well within the limits of allowed error, it is to be expected that the difficulties of crude oil measurement will be eventually overcome. At any rate, it is expected that the net results of the East Texas order will be to hasten progress and development in the metering of crude oil.



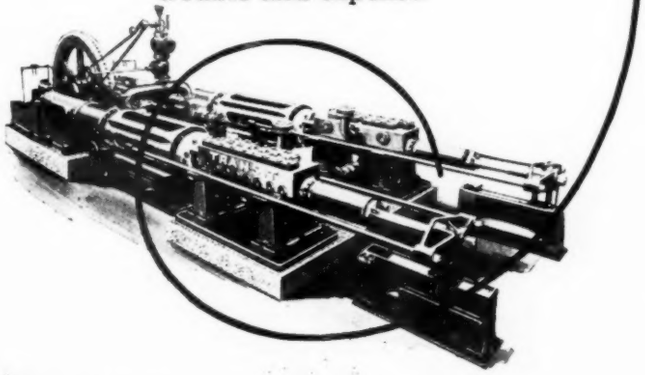
Here can be seen the meter and by-pass installation. In the background is the receiving tank.

TRANSIT
HOT OIL PUMP
FLUID BODIES
"float" in their mountings

TRANSIT
HOT OIL PUMPS
Have This Construction



SEE to it that the fluid bodies of your hot oil pumps are properly mounted, and you will side-step a lot of trouble and expense.



The body is supported at the center line of the bore, permitting expansion in all directions with no change in alignment. Each fluid body is mounted on two water cooled saddles as shown. There are no supports on the bottom.

Note particularly how advantageously the saddles are placed —no possible chance for any distortion of the body.

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Installation and Maintenance Pipe Line Meters

By W. C. KINSOLVING
Operating Superintendent of Sun Pipe Line Company
and Yount-Lee Pipe Line Company

THE writer at the present time has installed at each one of five main line stations a Venturi type meter on the discharge or high pressure side of the station. These meters have been in operation since the initial operation, when the line was started, August, 1931.

No attempt is here made to describe the engineering features of construction or technical theory of the operation of the meter. An attempt is merely made to set forth some of the maintenance features and some of the items to be guarded against if accuracy is to be maintained in this meter. Any other type of meter which is installed also will have certain pitfalls to be guarded against which will cause the meter to lose its accuracy and thus be of little service in checking the quantities pumped.

As originally installed there were two one-half-inch pressure tubes, one leading from the Venturi throat and one from the line just above the throat into the pump house to the mercury float chamber within the metering device. This records the pressure differential between the Venturi throat and the line. The whole theory of the Venturi meter is based upon this pressure differential and its accuracy must be insured for correct operation of the meter. As originally installed it was found that this meter would operate within 1 per cent error for quite some time and then suddenly check off 20 to 30 per cent. It was found that this was due to an accumulation of paraffin in the mercury float chamber so that the float was sticking on the sides of the chamber, thus causing the large inaccuracy. This was cured by placing water seals on the outside of the pump house in the one-half-inch tubes leading into the meter. These seals are nothing more or less than a piece of eight-inch pipe, bull plugged at each end, and filled completely full of water with the tubes leading into the meter also filled with water. The oil coming from the pipe line was tapped into one end of the water seal and the pressure of the oil transmitted through the water medium back into the meter so that in place of having oil in contact with the moving parts of the meter we have water. This eliminated the paraffin trouble.

Pair of Venturi Meters installed in pipe line station

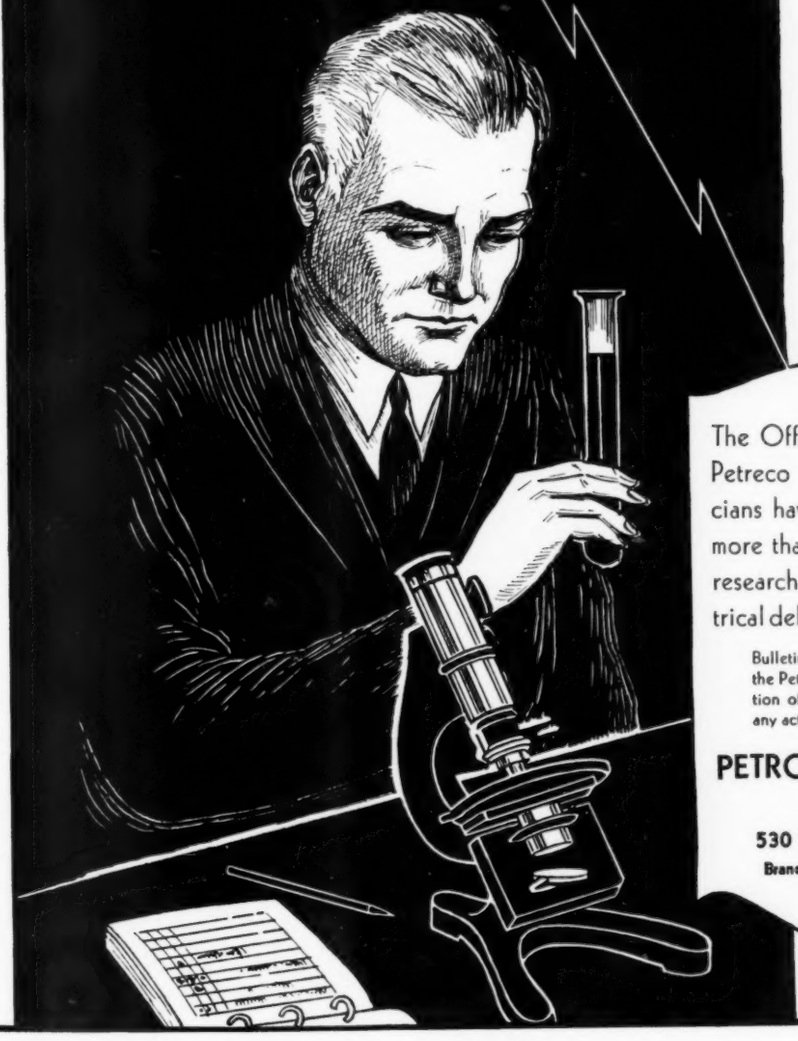
Another source of error is the accumulation or entrapping of gas in the tubes leading to the meter and the meter itself. This generally occurs when the pipe line has been shut down for some time and the meter float being quite a few feet higher than the pipe line itself, gas will tend to rise into the meter and accumulate there. If this gas is not carefully bled off it will cause inaccuracy due to expansion and contraction of the gas body in place of an inexpansible fluid medium. All station operators are instructed to carefully bleed the meters through a blow-off or bleeder line once each shift, as well as take particular care after the line has been down for any length of time. Of course, at each bleeding a small amount of fluid is lost and it is necessary to add more water from time to time to maintain the water seal.

Another source of inaccuracy that might develop will be an accumulation of paraffin or some foreign body in the throat itself. The meter calibration is based on a very accurate internal diameter measurement of the throat. If paraffin would accumulate at this point, changing this measurement, or some foreign body lodge in it, it will, of course, throw the meter off. Up to the present time we have not cleaned our Venturi throats for paraffin, as it is my belief that, due to the increased velocity of the oil through the restriction a scouring action will keep this throat swept fairly clean and, of course, there are strainers on the suction side of the stations to prevent foreign bodies from passing through the line.

All of the above are some of the pitfalls to be looked for on this type of meter. Any other type of meter has similar pitfalls to be guarded against, though, perhaps they are not these same ones. The point to be made from the above discussion is that all meters are dependent for their accuracy upon close supervision and maintenance. It is not to be expected that meters can be placed on crude oil lines, sealed up, looked at once a month and any kind of close accuracy obtained. If the proper supervision is not given to these meters eventually they will become inaccurate. Therefore, if they are to serve their purpose some system will have to be devised by the Commission to inspect, check and regulate all metering equipment at fairly frequent intervals. This will have to be under the supervision of an engineer with a knowledge of this type of equipment and one who knows the various factors which tend to render such types of equipment inaccurate.

The pipe line companies have no serious objections to meters. However, all of the operating departments clearly realize the limitations of such type of equipment and in fairness to all concerned, the Commission should see that these meters are so checked and regulated that there can be no doubt as to their accuracy.

THERE IS NO SUBSTITUTE *for* EXPERIENCE



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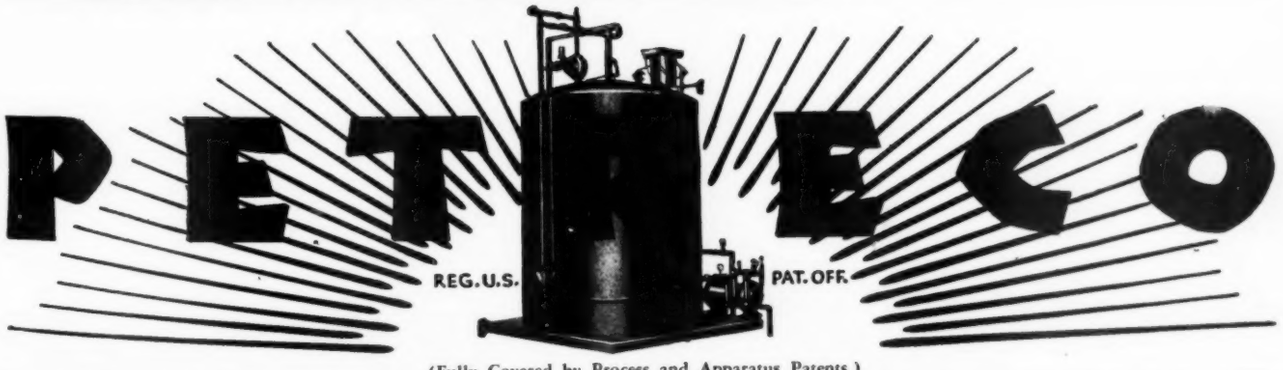


(Fully Covered by Process and Apparatus Patents.)

Installation of Oil Meters on Oil Pipe Lines

By R. D. HANLEY
Magnolia Petroleum Company

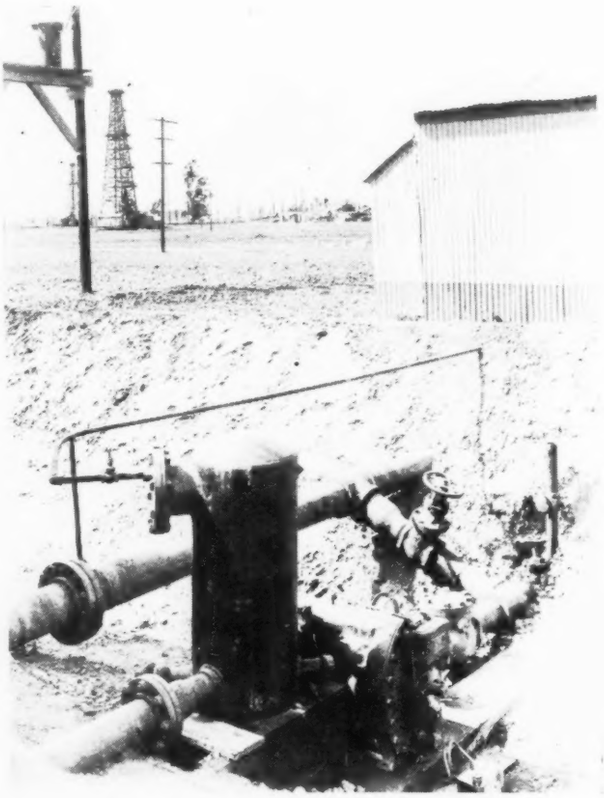
WITH the passing of a ruling by the Railroad Commission of Texas requiring the installation of meters on all pipe lines in East Texas transporting oil out of the field to distant terminals, local refineries, permanent storage near or in the field and to loading racks, the measurement of fluids flowing through pipe lines has become of major importance to companies engaged in transporting oil in that area.

Heretofore oil pipe line companies have accounted for the oil transported and handled by means of tank gauges. These gauges are dependent upon the strapping of the tank gauge tables, and the actual gauge of oil in the tank delivered by measurement. Whenever gauging was done the oil was at rest or the volume of oil going into or going out of the tank was negligible during the time of measurement.

The problem of measurement of the amount of oil going through a main pipe line that is operating continuously is an entirely different problem as the oil has to be measured "on the run" under pressure, and measured continuously.

There are at present two types of meters seemingly adapted to this type of work, the displacement type and the flow type of meters. In the displacement type of meter a constant volume of the fluid being measured is displaced in and out of the meter, and by means of gears and indexes these displacements are recorded and converted into standard units of measure, such as gallons, or barrels.

The flow type of meter is one in which the fluid being measured flows through a constriction, such as a venturi throat or an orifice plate, across which there is a pressure drop on account of the force necessary to overcome the resistance to flow. The meter measures this resistance to flow as a differential of pressure between the up and down stream side of the constriction. By using constants predetermined for each size line, each size constriction, or type of fluid, and by recording this differential pressure on a time chart the rate of flow for any instance can be determined and the quantity for any time can be calculated. In the flow type meter the recording gauge that records the differential pressure and time, can also be equipped with a pressure element to record the line pressure. Integrating devices are made for use with the flow type of meter that will record on a dial like a displacement meter, the actual number of gallons or barrels of fluid that have passed through the meter, thus on a flow type meter with an integrator a continuous dial reading is obtained, together with a graphic record that gives a static and differential pressure record with regard to time.



Three-Inch Bassler Meter equipped with Sampler and Air Eliminator

The type of meter to be used is dependent upon many conditions; such as size of line, pressure under which measurement is to be made, quantity of fluid to be measured, conditions of flow, such as intermittent or continuous, and cost of installation.

Regardless of the type of meter installed without the proper care being taken in installing and without the use of the proper accessories, the meter is going to be a source of grief and contention. The meter setting is of prime importance, for the good and accurate operation of the meter is dependent upon it. The accessories needed do not necessarily increase the accuracy of the meter but protect and help maintain the accuracy of the meter over long periods of time. The accessories necessary for a displacement meter are a gas or air eliminator, and a strainer. Both have an important part in protecting the meter. The flow type of meter only needs liquid seals to prevent any of the fluid being measured from coming in contact with differential mechanism and fluid, thereby causing corrosion and contamination.

The actual volume of liquid through a meter has to be connected back to a standard basis of temperature of 60 degrees F., and for this reason many of the meters have compensators that automatically take care of all variations in gravity, temperature and viscosity. With other meters the factors must be taken into consideration and the meter reading corrected by use of factors to obtain a correct volume on standard basis.

Both the displacement and flow type of meters have been used around bulk stations, refineries, and natural gasoline plants a number of years, both to measure total quantity of fluid and rate of flow. The orifice type of meter is particularly adapted for the type of work because the changing of plate sizes changes the capacity of meter, and with the integrating devices both the rate of flow and total quantity passed through the meter are recorded.

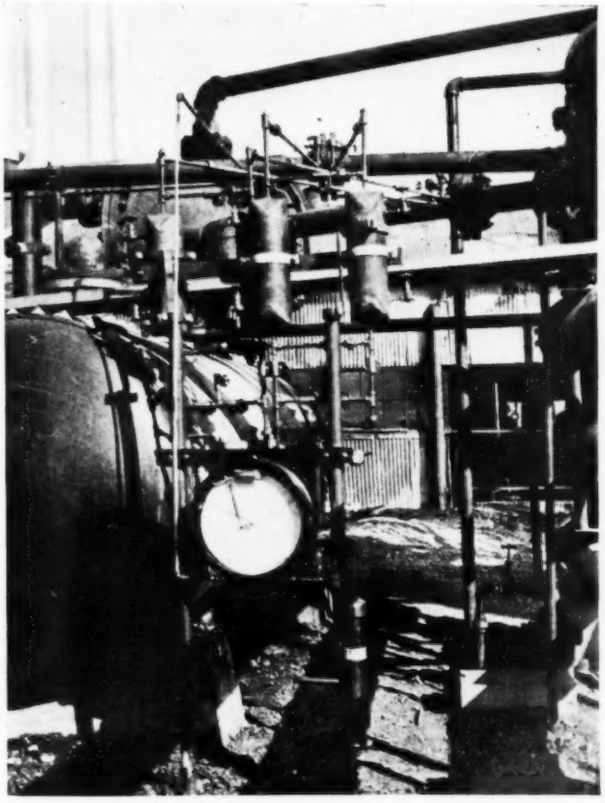
The accompanying illustration shows a meter on an oil pipe line. Note the air or gas eliminator.

There is one problem yet to solve on the installation of meters on oil lines, that is where by-passes around the meter are not allowed. Whenever the meter has to be inspected, checked, or repaired, it will be necessary to shut down the line for this to be done. The practical solution at the present time is to install two meters in parallel, the capacity of both equal to the capacity of the line, capacity of one three-quarters, and the other one-quarter, thus a flexible installation is obtained in which the full range of pipe line is taken care of, together with ability to repair meter without shutting down the line.

Problems Encountered in Use of Oil Flow Meters

By D. A. SILLERS
Superintendent Measurement, Lone Star Gas Company

OIL metering history is in the process of making in the East Texas oil fields. Faced with the necessity of measuring large quantities of oil flowing in pipe lines, there can be no doubt that engineering skill will find a practical and satisfactory solution to the problem. At first mistakes will be made and sad experience will be gained, but this experience will furnish a knowledge of the problem which will lead to its solution. The first problem that can be anticipated will be that resulting from paraffin building up on the surfaces of the venturi throat or on the face of the orifice plate used. Paraffin building up on a venturi throat will cause the meter to read high. Paraffin building up on the face of an orifice plate will first result in low meter readings, due to the fact that building up of the material results in a curved approach to the orifice instead of the square, sharp edge of the clean orifice plate. The meter will gradually become slower until such time as the paraffin begins to build up on the inside of the orifice itself and from this time on the meter will read faster and faster. It can be seen that keeping the throat or orifice clean is very important and it will be necessary to examine them at frequent intervals until it is determined at what intervals they should be cleaned.



Flow Meter on Mineral Seal Circulating System in gasoline plant

It may be that the paraffin problem can be handled by the application of heat sufficient to melt the paraffin and carry it on past the meter. When an orifice plate is used the melted paraffin could be tapped off through the connection at the bottom of the flange on the inlet side. This procedure could be compared to that of defrosting the cooling unit in an electric or gas refrigerator. If the paraffin problem becomes too serious it may be necessary to use a hot water or steam jacket around the venturi throat or orifice flange, automatically maintaining a constant temperature high enough to avoid paraffin deposit. This temperature could then be taken into account in the measurement factor.

The venturi throat or the orifice plate constitute the first and the primary element of a flow meter. The second element consists of the meter piping and seals between the primary element and the recording instrument. The seals should be placed as near as possible to the throat or orifice flange. Each seal should have a relief valve to the atmosphere and each pressure line should have a relief valve to the atmosphere at the highest point in the meter lines so that air or gas pockets can be eliminated. The piping should be installed in a smooth inline without sags or humps which might contain air or gas pockets. The seals should have small needle valve drains at exactly the same level, at the contact point between the oil and the water or prestone used as a seal, so that it may be determined at any time if the contact point between the oil and the seal is actually at the required level. The seals should be of sufficient horizontal area so that the movement of the mercury in the recording instrument would not result in materially raising or lowering the level of the contact point in the seal. With the seals properly designed, the seal contact point periodically checked, the gauge line piping kept without leaks, and the four vent valves tested periodically for air or gas pockets, we may consider that the piping or second element in the flow meter is in working condition.

The third element, the recording instrument, should give very little trouble. If a proper seal is used the mercury chamber should remain clean and if all adjustments are kept tight, the instrument should remain in calibration. Any friction in the pressure-tight bearing between the mercury chambers and the atmosphere can be readily detected by a jumpy motion of the recording pen when the instrument is subjected to false differentials obtained by manipulating the meter piping valves. If the pressure-tight bearing should leak any of the seal liquid or should be found to bind, it would be necessary to drain the meter and renew, repair or readjust the pressure-tight bearing. If a seal is used which will not corrode the meter parts, or precipitate foreign matter into the mercury; and if the pressure-tight bearing does not leak or bind, it should not be necessary to run a water column test oftener than once in six months or a year. This should be done before the seal liquid is originally put into the meter. Modern differential recording instruments give very little trouble if they are kept clean and are not abused. It may be safely predicted that most of the practical troubles of maintaining oil meters will be in connection with keeping the throat and orifice clean, in keeping the gauge lines tight, free from air or gas pockets, and in keeping the proper level in the seal.

Calibrating, Testing and Operating Orifice Meters for Use in Metering Oil

By W. R. McLAUGHLIN
Superintendent Measurement, Arkansas Natural Gas Corporation

AT present very little information is available in regard to the use of orifice or venturi type meters in metering oil on high pressure trunk lines from oil field pumping stations.

The present day differential recording apparatus of several prominent meter manufacturers for use on gas lines can be used in the measurement of oil provided they are of a sufficient working pressure. Also, the present day square edged orifice can be used with a fair degree of success with the greatest detriment being the accumulation of paraffin on the upstream side which must be removed periodically to insure proper measurement.

The modern type orifice fittings are the most applicable in trunk line measurement due to the ability to remove the orifice plate from the line without the use of by-passes and without interference to the flow of oil, and with a minimum of elapsed time during the examination. With the straight flange type the oil in the meter run must be disposed of to make an examination of the plate, but in the case of the modern type fitting no oil is lost.

It is the writer's opinion that a venturi throat used in connection with the present day differential recording apparatus might result in a higher degree of accuracy than the straight orifice type, and require less attention for removal of paraffin.

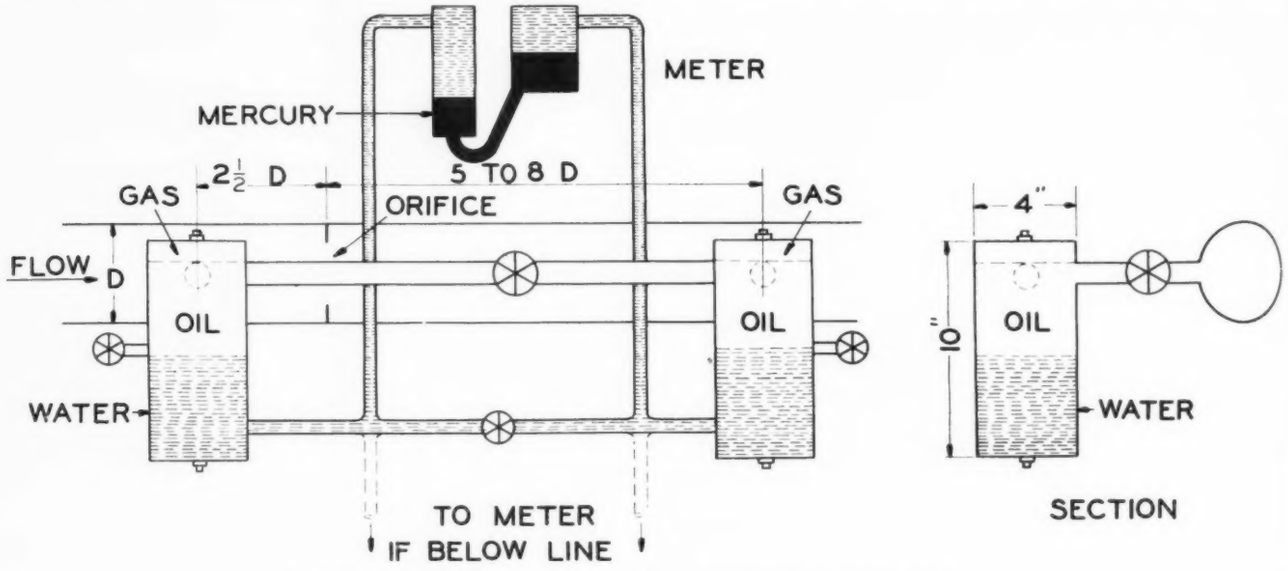
The differential recording apparatus should not be installed directly on the line as in the case of the gas meter but should be installed at least a few feet away, this being done to eliminate as much vibration from the pumps on the recording instrument as possible.

It is not necessary that the meter run be level as it will not affect the accuracy; however, the recording apparatus should be perfectly level to insure a free movement of the float in the chamber. The one-half inch gauge lines can be any length up to 200 feet, though they must be kept free from sediment to eliminate stoppage. The gauge lines should be elevated slightly above the recording instrument to avoid as much drainage as possible during examination of the plate.

As mercury is the sealing medium in the recording apparatus, it must be kept clean. Therefore the oil should not come in direct contact with the mercury. The practice at present is to use water in the one-half-inch gauge lines and on top of the mercury, the differential pressure at the line being transmitted to the recording apparatus with the water as a medium. During cold weather some trouble may be encountered by freezing, also if oil is used in the gauge lines it may congeal and create a fictitious differential. For this reason, it is the writer's opinion that some anti-freeze solution should be used in the instrument and gauge lines back to the flange. In this case a correcting factor should be used to correct the co-efficient for the specific gravity of liquid on the top of the mercury.

The flange connections should be equipped with traps to avoid accumulation of gases in the gauge lines. These traps should be installed on the gauge lines at the flange on the same level and in a vertical position, and should be tapped for one-fourth-inch valves at the same height on each trap. These valves are for the purpose of determining the height of the sealing medium when the meter is ready for operation. Two by-passes should be installed, one to connect the top of the traps and one to connect the bottom of the traps so that the heads of the sealing liquid in the traps can be equalized by opening the by-pass valves when the main gauge line valves are closed at the flange.

After the installation is complete, the traps, meter and connections should be filled with the sealing liquid. After this is done, the valves on the high side of the orifice should be opened slightly, allowing the liquid to rise in the meter and expel the air in the gauge line through a small opening at the highest point on the differential gauge piping. This opening should be closed when the sealing medium appears. Next, the one-fourth-inch valves on the traps should be opened until oil appears and then closed. When this condition exists the differential pin should register zero. All by-pass valves



Liquid Seal used on Flow Meter on oil line. Courtesy American Meter Company

should then be closed and the valves at the main taps at the flange should be opened and the meter is ready for operation.

To test the gauge for accuracy, the meter should be taken out of service and a one-fourth-inch nipple in the shape of a "U" connected to a one-fourth-inch opening on the high side of the meter manifold. To this should be connected a straight glass tube of sufficient length to accommodate a head of water equal to the maximum differential range of the meter. Next, a one-fourth-inch plug on the low side of the meter manifold should be removed to allow a small amount of pressure to pass into the meter by opening the valve on the high side of the orifice at the tap until liquid appears at the one-fourth-inch opening. As soon as liquid appears at the opening the

Meter Connections on 12-inch oil line

valve on the high side of the flange should be closed and the adjustable scale on the glass tube set for zero position. Next, all by-pass valves on the manifold should be closed. Thereafter by opening and closing the high side valves at the flange and allowing the liquid column to rise and fall in the glass tube, a check can be made between the recording instrument and the liquid column in the glass tube above the zero mark. One inch of differential on the chart is equivalent to 0.926 inches of water above the zero mark in the water column.

No static tube is necessary in the recording instrument for an orifice or venturi type meter as liquids are nearly incompressible.

Should the meter be installed near the discharge of a reciprocating pump station, some sort of cushioning device should be installed to eliminate as much pulsation as possible. Restricting bushings can be used in the mercury chamber of the recording instrument to obtain a more uniform registration on the chart, however, this does not remove the pulsations from the flow which cause an inherent inaccuracy since co-efficients are based on uniform flow.

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Flow Control Developments

By L. G. MARSH☆

THE gasoline recovery and pressure distillate stabilization units at the West Tulsa refinery of the Producers' and Refiners' Corporation utilize in the double proportional flow controller one of the newest developments in the field of automatic liquid level and flow regulation.

This installation is designed to control the charge to the stabilizer in relationship to the production of raw distillate and at the same time control the flow of reflux to the top of the stabilizer column in direct proportion to the rate of feed. Two units are in service, one in conjunction with the operation of the stabilizer handling raw distillate from the cracking stills and the other on the stabilizer handling the absorption plant gasoline.

The double proportional flow controller represents a progressive step on the part of the instrument manufacturer in his efforts to meet the refiners' problems and comprises one of the most scientific and flexible systems of flow regulation yet offered to the refining industry.

The installation proper comprises three distinct units, in addition to the control valves. A liquid level recorder, which measures and records the level in the surge tank, is "tied in" with two rate volume regulators, one of which controls the feed from the surge tank to the stabilizer and the other the flow of reflux from the accumulator to the top of the stabilizer column.

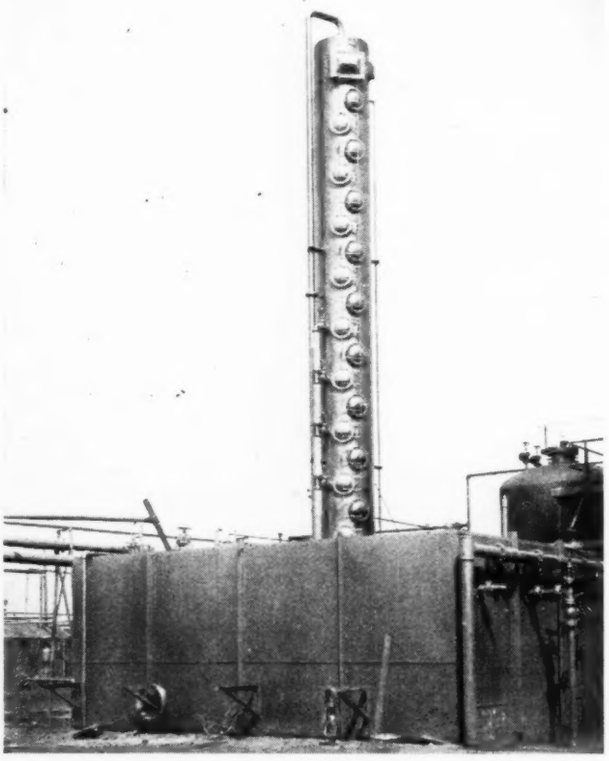
As the plant production of raw distillate (and correspondingly the level in the surge tank) builds up, the liquid level recorder automatically changes the "setting point" of the rate volume regulator, to which it is connected at the right, to give whatever increased rate of feed is necessary to balance or equal the rate of raw distillate production. The action of the flow recorder simultaneously changes the "setting point" of the second rate volume regulator, to which it is connected at the left, to such a point as is necessary to increase the rate of reflux in direct proportion to the rate of feed. On a decrease in the plant output of raw distillate, the installation correspondingly reacts automatically to decrease the rate of feed and the charge of reflux to the point necessary to balance the new conditions.

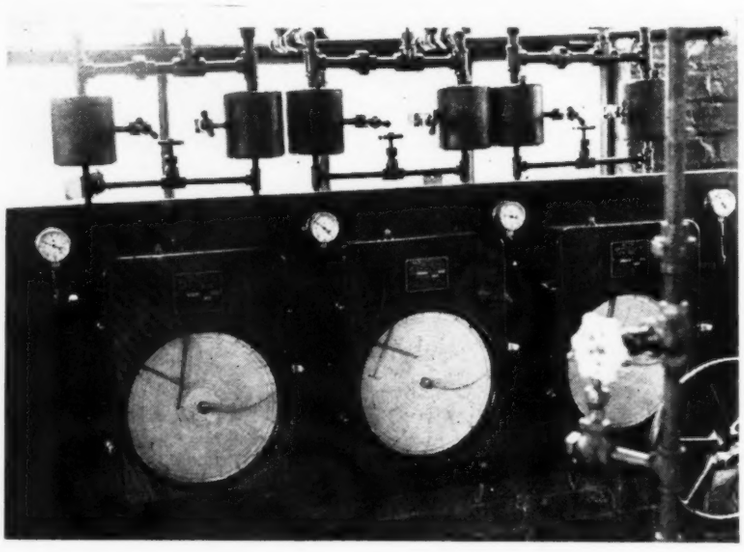
The liquid level recorder essentially is an orifice meter with one "U" tube connection into the surge tank near the top and the other into the tank near the bottom. A change in liquid level is reflected in a change in differential pressures between the upper and lower sections of the tank and this is registered on the liquid level recorder chart.

The rate volume regulator for controlling the raw feed to the stabilizer maintains a constant rate of charge for a given "setting" of the regulator by automatically controlling the speed of the charge pump. This is accomplished through a diaphragm valve in the steam supply line to the pump. The rate volume regulator for the reflux control likewise maintains a constant charge of reflux for a given "setting" of the regulator by controlling pump action through a diaphragm valve in the steam supply line to the reflux pump.

The entire installation is an adaptation of the liquid level regulator and the rate volume regulator which have been used for a long time in the refinery and gasoline industries for controlling levels in bubble towers, reaction chambers, etc., or the charge to stills, absorbers, "kettles," etc., and is a correlation of their action in a manner to meet the exigencies of modern recovery and stabilization plant operation. Its efficiency is reflected in a uniformity of processing and a more positive control over the factors on which smooth plant operation are dependent.

This refinery processes Mid-continent crudes. The reduced crude is cracked in Dubbs units to manufacture high octane gasoline.





(Above) Cracked Gasoline Stabilizers (and below) Flow Control Instruments on Stabilizer at Producers' and Refiners' West Tulsa, Oklahoma, Refinery

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In answer to the many inquiries concerning this remarkable engine, we have prepared an illustrated Brochure, containing facts and figures of interest to progressive oil men. Send for your copy.

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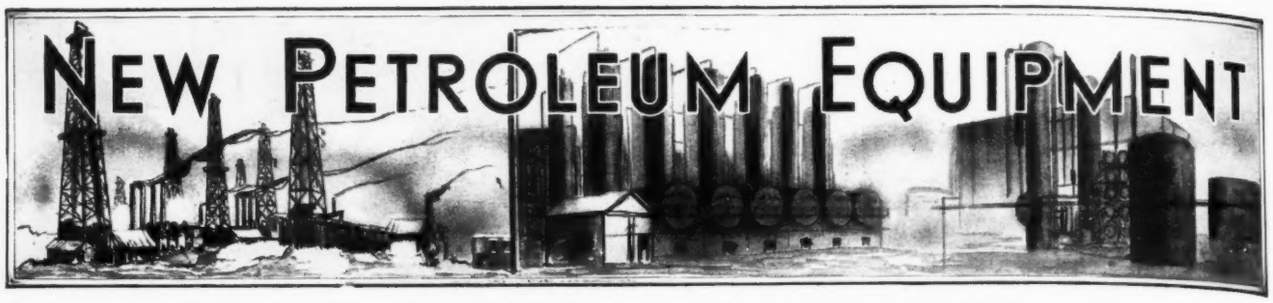


Oil Well Supply Heavy Duty Power

THE Oil Well Supply Company, Dallas, Texas, announces the new Imperial No. 80 oilbath, geared power for heavy duty pumping, with a rated capacity of 80 horsepower at 20 r. p. m., 115 horsepower at 30 r. p. m. According to the makers, this power is featured by its compactness and general small size, which eliminates large structures for housing as well as reducing the maintenance cost.

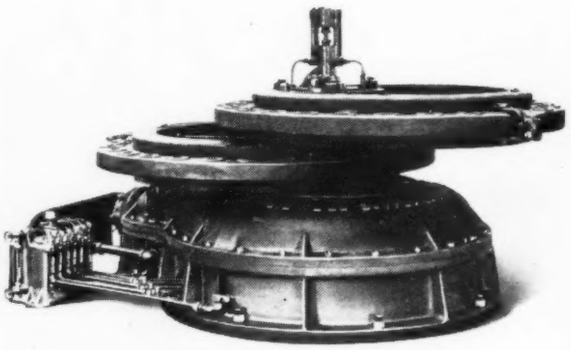
It is an extremely rugged design of the overpull eccentric type—driven through double reduction gears. The base and spindle are cast integral, assuring alignment of the unit and an oil-tight reservoir for the oil bath. The eccentrics and straps have unusually heavy cross sections and wide bearing surfaces.

Easily renewable bronze spindle bushings, babbitt lined eccentric straps and case hardened clevis pin bushings are some of the exceptional mechanical features.

Roller bearings support the high speed pinion shaft and the intermediate speed shaft—the only two rotating shafts in the power. The main gear and the two eccentrics are all keyed together and rotate as a unit about the spindle, with their weight carried on a ball bearing.

No. 80 power may be belt-driven by a gas engine or electric motor, or directly connected to a motor.

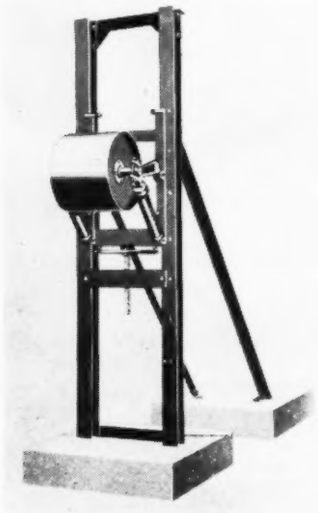
All gears and some of the anti-friction bearings run in the 35-gallon oil bath in the gear case. Those bearings that are above the oil bath are fed by individual positive force feed oil lines from a mechanical lubricator, chain driven from the



pinion shaft. Oil from these bearings drains back into the main oilbath, from which a supply pipe leads to the force feed lubricator to complete the return system.

National Type SR Belt Tightener

THE National Supply Companies have perfected and are now offering for sale in the oil country, a new type belt tightener, known as the National Type SR. This tightener is designed to apply tension automatically to standard rig endless belts. It is of the floating type and will maintain correct tension with varying conditions of load and atmosphere.



The construction of the tightener consists of a sliding carriage closely guided in a vertical frame with pulley mounted in a swinging bracket pivoted to the carriage. Alloy steel springs furnish the tightening force and all adjustments can be made with the belt in motion. The carriage can be clamped in any position and the pulley locked at top or bottom of the float to eliminate the floating feature when pulling rods or tubing.

The available tightening force of the National tightener is said to cover the entire range needed for ordinary installations. The excessive stretching of a new belt due to overload is eliminated, as the tightener permits holding exact tension necessary to transmit the load without slippage. The tightening force applied to the belt is registered by an indicator.

Easy adjustment is secured by means of an adjusting screw which fastens to either end of the carriage and anchors to the frame in various positions. During the top half of the travel, the adjusting screw fastens to the bottom end of the carriage and the handwheel is below the pulley. For the bottom half of the travel, the screw is attached to the top end of the carriage and the handwheel is above the pulley. The location of the handwheel is, therefore, most convenient for the operator.

The steel pulley is mounted on Timken roller bearings of ample capacity. The stationary pulley shaft is adjustably mounted in the swinging bracket to permit pulley alignment. Alemite lubrication is provided for these bearings.

Descriptive literature, giving complete details of construction, is available upon request to the National Supply Companies.

Twenty years of welding experience are yours in this

new Crane line

and

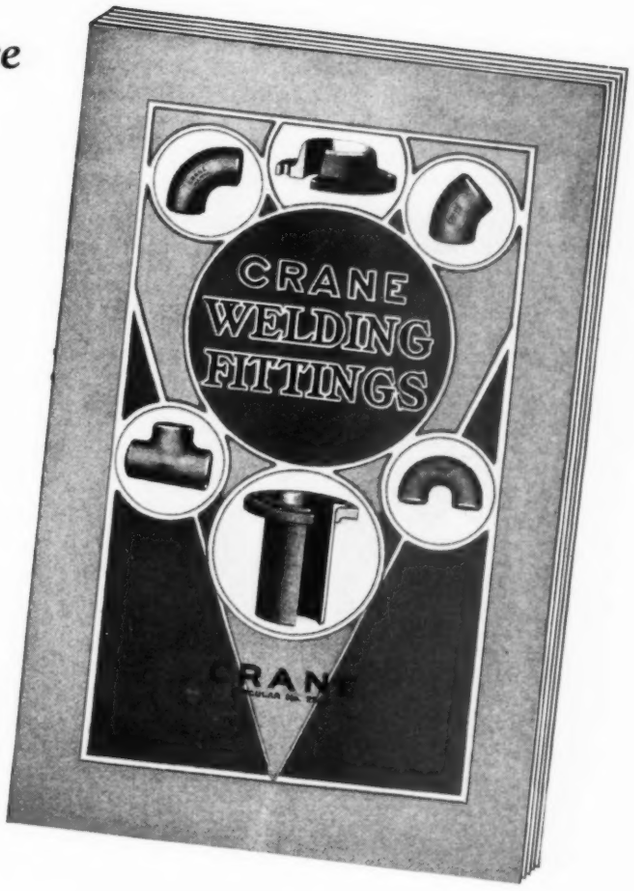
in this booklet

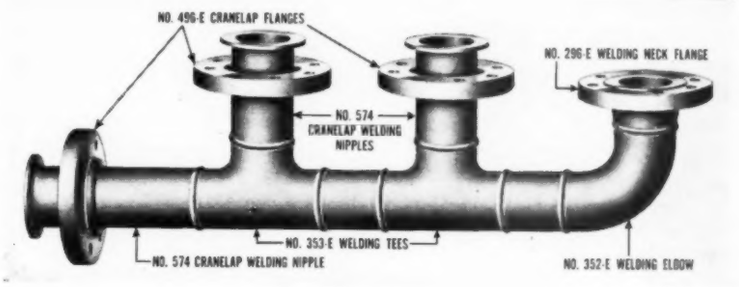
◆

The recently announced *complete* line of welding fittings shown in our new booklet No. 236-A has been developed during more than twenty years of research, experience, and experiment. In this time it has been demonstrated that welding is an eminently satisfactory method of fabricating pipe joints, both from an economical and an engineering standpoint, and this line will occupy approximately the same space as a screwed fitting installation.

These fittings represent, in some cases, a radical departure from older manufacturing methods. They emphasize clearly the engineering leadership which has characterized Crane Co.'s progress during the seventy-seven years it has been engaged in the manufacture of piping materials.

The complete story of these fittings, with many interesting illustrations of their adaptability in simplifying piping systems will be found in booklet 236-A. Send us this coupon for your copy.





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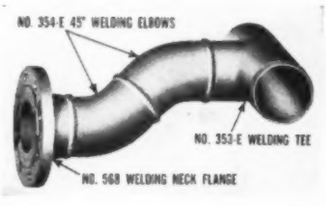
These illustrations from the new Crane booklet on welding are from the comprehensive section on the application of the new welding materials.



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CRANE

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NEW YORK: 23 W. 44TH STREET
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CRANE CO., 836 SOUTH MICHIGAN AVENUE, CHICAGO, ILLINOIS (P.E.-6)

Without charge or obligation, will you please send me your booklet 236-A on *Crane Welding Fittings.*

Name..... *Address*.....

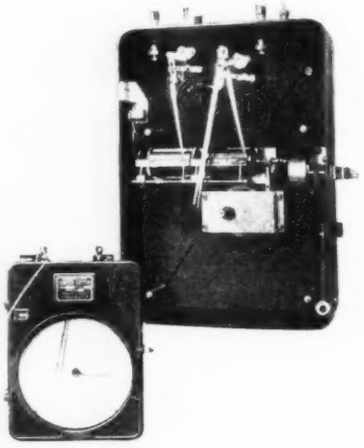
Firm Name.....

Metric Integrating Orifice Meters and Flowmeters

THE Westcott Integrating Orifice Meter, made by the American Meter Co., New York City, is the well-known Westcott Orifice Meter equipped with an integrator which gives a totalized indication of the quantity which has passed through the orifice for all rates of flow and all variations of pressure.

In any type of orifice meter or flow meter the quantity of gas or steam varies as the square root of the differential and as the square root of the pressure. Therefore, any change in the pressure affects the rate and the volume. A 10 per cent change in pressure will produce the same effect or change in the rate of flow as a 10 per cent change in the differential.

In this integrator the effect of the pressure on the rate or the volume is continuously applied for any value or change in pressure from the perfect vacuum to the maximum pressure range of the instrument. Therefore, any multipliers or factors for change in pressure are not required. It is not necessary to regulate a pressure in order to assume that it is constant.

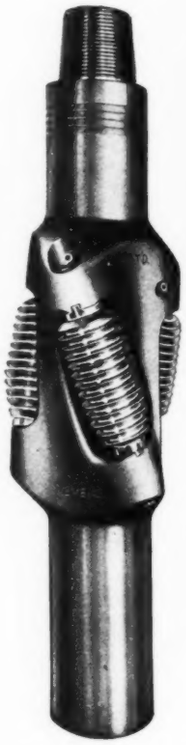


The integrator extracts the square root of the differential each minute and multiplies the square root of the differential by the square root of the absolute pressure. The sum of the products is continuously totalized on a counter index. The difference between the readings obtained at the end and at the beginning of an interval multiplied by the meter constant (the unit hourly coefficient of the orifice) gives the quantity which passed through the orifice during the interval.

Sievers Reamer

A REAMER which employs a radically different and novel cutting action is being marketed by the Security Engineering Company of Whittier, Calif., and is known as the Sievers Reamer.

The shearing action of the mounted cutters may be compared to that of a disc-harrow as used in the agricultural industry, and it is claimed that the tools incorporate certain features which enable them to be successfully used as drilling bits and core-barrel stabilizers and hole conditioners, as well as for straight reaming.



The cutters are mounted in the reamer body at an angle to the vertical and are designed in such a manner that the disc-like cutting teeth strike the hole at an angle of shear, thereby slicing away the formation. This angular lay of the cutters causes the teeth to be in contact with the formation throughout a considerable part of the circumference of the hole, and the makers claim it is impossible to slide the tools through tight spots in the hole without first reaming the hole out to gage.

The Sievers Reamer is manufactured in all standard sizes and the bodies are so constructed that either tool joint end may be run up or down.

Further information about this reamer may be obtained by writing to the Security Engineering Company at Whittier, Calif.

Dearborn Concentration Hydrometer

THE Dearborn Concentration Hydrometer, a new device being marketed by the Dearborn Chemical Company, 310 South Michigan Avenue, Chicago, is a rapid and convenient method for the determination of total dissolved solids.

The occasional testing of boiler water samples for concentration removes the element of doubt as to blow-down requirements. The boiler water sample may be taken from the water column or from the blowoff connection.

It is a simple matter to determine concentration and blow-down requirements with this instrument, which is priced at $7.50 each.

Wagner Electric Split Phase Motor

WAGNER Electric Corporation, 6408 Plymouth Avenue, St. Louis, Mo., has announced two new split-phase motors. They are the 44RB and 56RB models, completely redesigned for ultra-quiet, vibrationless, cool and trouble-free operation.

New features incorporated in these two new motors include drip-proof end-plates, liberal wool-yarn lubrication, handy conduit box adjustable in four positions and a redesigned switching mechanism on the 44RB. The 44RB motor is made in 1/30 to 1/20 horsepower sizes, while the 56RB comes in 1/8, 1/6 and 1/4 horsepower ratings, standard revolutions per minute are 1725 and 1140, all cycles.

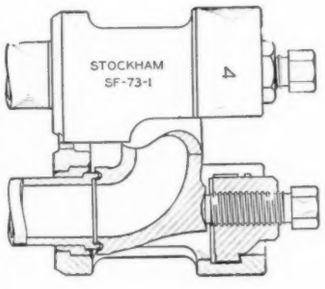
Wagner type RB motors are single-phase motors, having two stator windings, one winding in use at all times, and the other (auxiliary) winding during the starting period only. An outstanding feature of the motors is the quick break switch which will not warp, rust, bend, loosen, ground or in any way give trouble.

The Wagner Electric Corporation will be glad to furnish additional data and information on these motors to anyone writing them at the above address.

Complete Line of Return Bends

THE Stockham Pipe and Fittings Company of Birmingham, Ala., has recently announced a full line of header box assemblies, to provide for every petroleum engineering requirement or preference in the matter of return bend fittings for cracking stills, tube stills and condenser coils.

The first header box assembly introduced by Stockham three years ago was the Stockham-Fantz Type HPR return bend. This return bend, which may be furnished in the analysis of steel best adapted for the high temperature and corrosive conditions encountered in any specific case, calls for the use of mill upset and machined tubes. The HPR type bend is furnished with the ring type joint. The HPB type differs only in that it is furnished with the relieved bell joint.



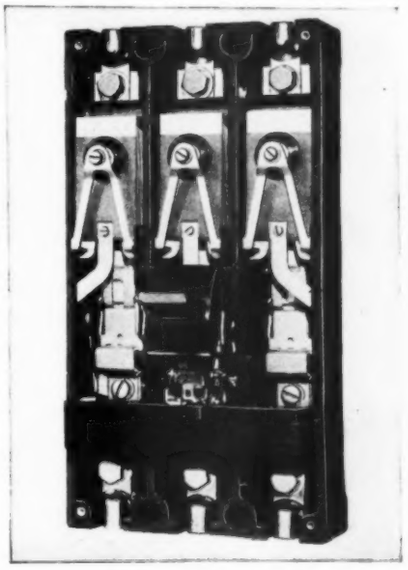
Where low pressures are used and where corrosion is not serious, Stockham offers Type SER, which uses plain end tubes threaded on the end for the joint at the refinery. The yoke is made in two parts so that each tube, end collar, and half yoke may be installed as a separate unit.

In addition, the Stockham line includes a sectional head and a box header, both of which have the tubes rolled in. These are types RS and RB and while they are a usual type the higher octane gasolines generally call for the more extensive use of type HPR.

AB "De-ion" Circuit Breaker

FOR circuit protection in refineries, homes, industrial plants, mines—in fact, wherever electricity is used — a safe flashless device has been developed by the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa. It is known as the AB "De-ion" circuit breaker.

The manufacturers claim the "De-ion" breaker has nothing to be replaced or renewed; it can be reclosed by anyone as quickly and easily as a switch. It cannot be held closed against an abnormal overload or short circuit, nor can it be blocked to prevent opening the circuit; its rating cannot be changed by unauthorized persons. It has a time lag preventing unnecessary tripping on slight, momentary overloads.



The "De-ion" breaker is so enclosed in a molded composition box that no live parts are exposed. A handle, like that of a switch, protrudes through the cover to provide means for manual operation and for reclosing the breaker after it has been tripped, but the remainder of the mechanism is entirely enclosed.

The operating mechanism is arranged to provide quick make and quick break. The contacts, which are trip free of the handle, are held in the closed position by a toggle composed of two sets of links, one of which is fulcrumed to the contact mechanism, and the other on a cradle beam pivoted on the frame at one end and latched to the trip mechanism on the other end. The trip mechanism consists of a bi-metal thermal unit calibrated to trip at 125 per cent overload. On breaker of 50 amperes or more an additional trip of the magnetic type trips the breaker instantly on short circuits.

Upon being released by the trip mechanism, the cradle beam moves, permitting the toggle linkage to break and the contacts to open at high speed.

When the contacts open the arc is drawn through a series of small parallel plates, one-sixteenth of an inch apart. Between the plates a radial magnetic field is created by a near-by coil. The arc creates another magnetic field which moves the arc into the radial field. The plates absorb so many free ions that the arc is destroyed.

Hobart Constant Arc Oil Field Welder

THE Hobart Constant Arc Welder, driven by a six-cylinder, self-starting, gasoline engine, has a continuous service rating of 400 amperes at 40 volts.

The new Diverter Pole type generator, exclusive with Hobart, is embodied in this machine, together with the Trip Range, "Unitrol" Dial and the Navy type, twin-coil laminated-core, reactance.

This new Hobart Welder is available in the electric motor driven type, as well as in the above mentioned gasoline engine drive design. It is offered by Hobart Brothers Co., Troy, Ohio.

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STUFFING BOX
CASING HEAD
FORGED STEEL—TYPE C

STRENGTH . . . Body forged from A. P. I. Grade C steel . . . split gland and seat of steel castings . . . outlet of extra heavy steel, electric arc-welded to the body.

SAFETY . . . Each body is given a 1000-pound test before shipment . . . test loads of more than twice the weight of the average casing string have been placed on the assembly.

ECONOMY . . . An efficient all-steel head, amply strong, yet light in weight and easy to handle, furnished at materially reduced prices.

Available in the most commonly used sizes, with one 2-inch outlet furnished as standard. Descriptive literature free on request.

THE NATIONAL SUPPLY COMPANIES

Slow-Speed, Long-Stroke, Straight Lift Pump

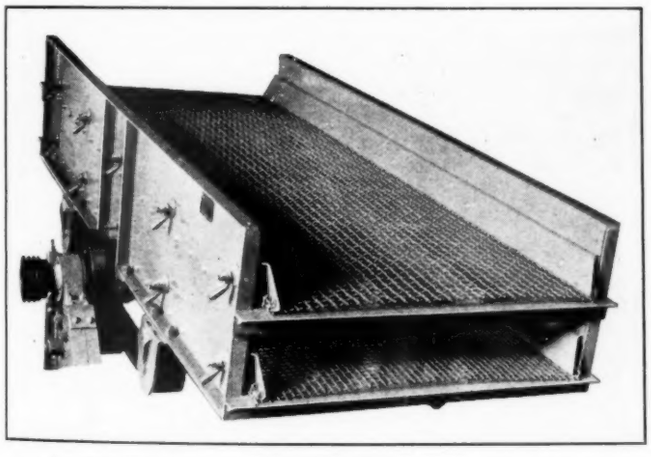
THE Cameron Iron Works, Inc., 711 Milby Street, Houston, Texas, has announced a new slow-speed, long-stroke, straight-lift pump from designs of Tracy Park of Houston. A 2¼ inch working barrel, standard A. P. I. standing and traveling valves and ¾ inch rods are being used. The unit has been pumping from the 1500 foot level of a well more than 6,000 feet deep. The designer calculates that by reducing the pumping speed to one stroke per minute, or by increasing it to four strokes per minute, and by selection of working barrels and tubing ranging from two-inch to four-inch diameter, various fluid displacements from 25 to 1,000 barrels per day may be obtained.

The construction of the new unit is heavy and simple. Large shafts and roller bearings, with large oil reservoirs throughout requiring very little attention, are provided. The unit is furnished by the manufacturer so as to eliminate field fitting or machine work when installing. It consists of two major sections which can be assembled in five hours by four men.

Link-Belt Heavy-Duty Vibrating Screens

TWO new types of Vibrating Screens have just been announced by Link-Belt Company, Chicago, Ill. These are known as: (1) Link-Belt Positive-Drive-Type, Heavy-Duty Screen and (2) Link-Belt Unbalanced-Pulley-Type, Heavy-Duty Screen. Both of the screens are made in either the single or multiple deck designs.

In the Positive-Drive Type Screen, the amplitude of vibration is fixed at the factory, to suit the work the screen is to do. Any given amplitude will cover a wide range of screening surface openings. The angle of the screen inclination, the speed of operation and the direction of the rotation, all are readily changed at any time to suit the kind, size and condition of materials to be screened. The rotation determines whether the vibrations are with or against the flow of the material.

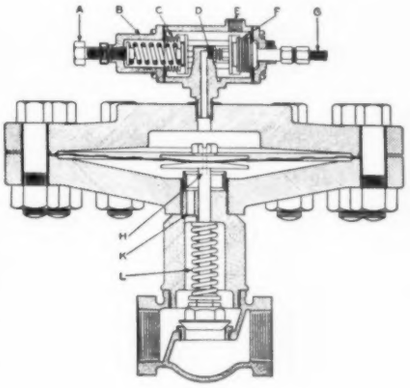


The double deck screens are placed under tension crosswise by side tension members which also serve as wearing plates and prevent material from leaking along the edges. Only the screen cloths need to be removed when replacements are required.

The Unbalanced-Pulley-Type Screen is available with single or multiple decks, for high speed work where the material is of a sticky nature, and on close-sizing problems where the screen openings are not large.

Tag Steam-Operated Controller

THE new steam-operated temperature and pressure controller manufactured by C. J. Tagliabue Manufacturing Company, Brooklyn, N. Y., utilizes, without waste, the pressure of the steam to operate a diaphragm valve. Variations in the pressure do not affect the accuracy of control as a differential pressure above and below the diaphragm governs the steam valve opening.



A feature of this controller is the compact control head which houses the control port as well as the thermostatic bellows and, according to the makers, definitely eliminates leakage, corrosion and possible injury from without.

The normal position of the steam valve is closed. Steam enters the valve above the seat and passes at once into the lower diaphragm chamber through opening (K), pushing the diaphragm upward and opening the steam valve. There is also an opening (H) in the valve stem which allows steam to enter the upper diaphragm chamber. If the steam in the upper diaphragm chamber is not allowed to escape, both chambers will have the same pressure and the valve spring (L) will close the steam valve.

If, however, the steam in the upper diaphragm chamber is allowed to escape through control port (D), which has a larger opening than (H), the pressure above the diaphragm will be less than the pressure below the diaphragm and the steam valve will be opened by the differential pressure pushing the diaphragm upward. The extent of the steam valve opening depends on how fast the control part (D) allows steam to escape from the upper chamber. Hence the steam valve may be wide open, tight shut or in a throttling position.

The control port (D) is operated by the thermostatic bellows (F), a part of the usual thermostatic system which includes a bulb and connecting tube (G). (C) is a pressure equalizing bellows and seal for preventing steam from leaking through the pressure and temperature setting screw (A). (E) is a connection for control port escapement.

When the bulb is at the controlling temperature, it exerts a moderate pressure in the bellows which expands and partially closes the control port (D), allowing just enough steam to escape from the upper diaphragm chamber to maintain the correct differential so that the steam valve can pass enough steam to hold the temperature.

When the bulb is at a higher temperature than that for which the controller is set, sufficient pressure is exerted in the bellows to close the control port (D). The steam pressure in the upper and lower diaphragm chambers is now equal and the spring (L) closes the steam valve.

When the bulb is at a lower temperature than that for which the controller is set, the pressure in the bellows is reduced so that it contracts enough to open the control port wide, allowing more steam to escape from the upper diaphragm chamber than can enter through opening (H). The pressure below the diaphragm is now enough to counteract the pressure of the spring (L) and the steam valve opens wide.

RUNNING TOUR
With Men In The Industry

M. J. McLaughlin

Mark J. McLaughlin, vice-president and manager of production, Magnolia Petroleum Company, has returned to his Dallas, Texas, headquarters following a tour over the Mid-Continent fields.

The Hercules Oil Company, recently formed to handle general marketing and refined products by J. M. Bradshaw and W. D. Brookover, is located at 606-607 Wilson Building, Dallas, Texas. Mr. Brookover was formerly vice-president in charge of production for the Panhandle Oil and Refining Company of Wichita Falls, Texas.

W. P. Hickman of the Barrett Company, has been transferred from the Chicago office to the Birmingham, Ala., district.

E. A. Sawyer, field foreman for The Texas Company, has been transferred from the Sasakwa, Okla., field to Cromwell, Okla.

R. A. Pugh, warehouse foreman, Gulf Production Company, and formerly located at Luling, Texas, is now living in Thompsons, Texas.

C. H. Kincaid of the Halliburton Oil Well Cementing Company, formerly located at Painted Post, N. Y., is now in the Oklahoma City district.

B. L. Prince, formerly warehouse foreman for the Magnolia Gas Company at Bethany, La., is now with the United Gas System and is located at Jackson, Miss.

G. R. Henson, until recently division exploitation engineer for the Shell Corporation at Tulsa, Okla., has been made chief exploitation engineer of the production department, with headquarters at St. Louis, Mo. Mr. Henson joined the Shell organization at Mineral Wells in 1918. He has successively held the following positions before his appointment to the St. Louis office: Field engineer at South Bend, Texas; assistant engineer, Tulsa; general field engineer at Dallas and Tulsa, and division exploitation engineer at Tulsa. W. H. Morrison, who was exploitation engineer at Seminole, is now acting division exploitation engineer, Tulsa, succeeding Mr. Henson.

G. R. Henson

V. C. Canter recently joined the Frick-Reid Supply Corporation, and will confine his activities to refinery equipment sales. For the last several years, Mr. Canter has been in the equipment sales business as a partner in the Vinson-Canter Company, Tulsa, Okla. In addition to his sales work, he has had much experience in plant research and operation.

V. C. Canter

C. O. F. Jenkin, refinery superintendent for the Shell Petroleum Company, has been transferred to the Wilmington, Calif., refinery from Martinez, Calif.

Clyde W. Campbell, drilling contractor, has moved to Marietta, Ohio, from Olean, New York.

G. H. McCann has recently been appointed acting chief engineer of the Anglo Persian Oil Company in Persia.

Shapleigh G. Gray, petroleum engineer, the Texas Company, has been moved from Shreveport, La., to Marshall, Tex.

George E. Shelton of the Universal Oil Products Company, has been moved from Bradford, Pa., to Houston, Texas.

M. E. Tannahill, previously chief gauger at Jenks, Okla., is now at Altoona, Kansas, for the Sinclair-Prairie Oil Company.

Roy E. Bullock, district superintendent, Skelly Oil Company, previously located at Whittenburg, Texas, has been transferred to the Seminole, Okla., district.

B. M. Laulhere has recently been appointed engineering supervisor for the Southern California Gas Company, Los Angeles, Calif. He has been superintendent of construction for the past 15 months for the Southern Fuel Company.

Russell G. Davis of the Chain Belt Company has been transferred from Houston, Texas, to Chicago, Ill.

W. D. "Bill" Teubner, assistant district manager for the Hill, Hubbel division of General Paint Corporation, Tulsa, has been on a tour of the principal Texas cities in the interest of his company.

W. D. "Bill" Teubner

INGERSOLL-RAND, 11 Broadway, New York City, has prepared a small circular on "Air Starting Units for Internal Combustion Engines." This circular takes up various starting units and has interesting drawings and tables of dimensions.

GEARMOTORS, consisting of speed reducers compactly combined with induction motors into general purpose unit drives are the subject of a new publication, Leaflet 20536, issued by the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.

FACTS TOUCHING ON FRACTIONATING AND ABSORPTION PROBLEMS is the title of a new booklet published by the Leader Iron Works, Inc., of Decatur, Ill. Factors entering into the design of fractionating and absorption units are discussed in the booklet, along with overall operating efficiency.

"EFFECT OF CRUDE PETROLEUM PRICE UPON PRODUCTION OF CRACKED GASOLINE," by George B. Murphy, manager of the Riverside Laboratories of the Universal Oil Products Company, Chicago, Ill., has just been put out by this company as booklet No. 100. It is a mathematical study of the relationship between crude oil price structure and production of cracked gasoline. Copies may be obtained free.

The 1932 issue of the "OIL & PETROLEUM YEAR BOOK" by Walter E. Skinner, has just been issued.

Covering 442 pages the book contains particulars of 621 English and Foreign Companies—Producers, Refiners, Dealers, Transporters and Oil Finance Companies, including the principal American and Foreign Companies. Lists are also given of the officials connected with the Companies and comprise 2,330 Directors, 315 Secretaries and 184 Consulting Engineers, Managers, Agents, etc., their names and addresses and company connections.

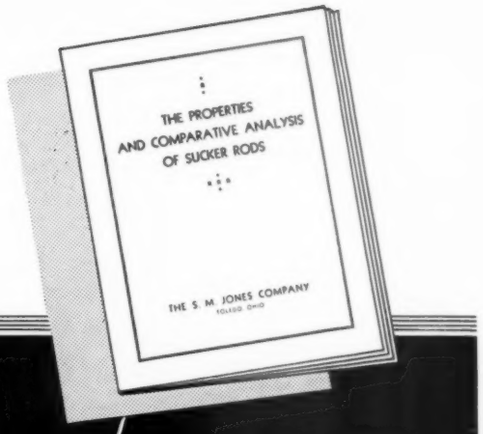
The particulars of each company include the directors and other officials, date established, location of property, purchase consideration, number of wells sunk, oil production and description of work in progress, capacity of refineries, capital, calls, dividends and financial position as disclosed by latest accounts, also highest and lowest prices of the shares for the last three years and latest price.

The book is published by Walter E. Skinner, 15, Dowgate Hill, Cannon Street, London, E. C. 4. Price 7s. 6d. net or post free (Abroad) 8s. 6d.

FOSTER WHEELER CORPORATION, 165 Broadway, New York City, has published a new pamphlet entitled "Vacuum Refrigeration Systems." The pamphlet describes a new method of refrigeration by evaporating, under high vacuum, a portion of the water or brine to be cooled.

MOTORS—is the subject of a new 22-page bulletin on squirrel-cage motors issued by the Wagner Electric Company, St. Louis, Mo. The bulletin describes the seven types of squirrel-cage motors, gives application tables, speed-torque curves, complete construction details. It is in loose-leaf form to permit keeping up to date at all times.

AMERICAN PETROLEUM REFINING by H. S. Bell and published by the D. Van Nostrand Company, Inc., New York, N. Y., continues to be popular with the trade. The data included are of fundamental information of essential interest to the owner, manager or engineer contemplating installations of refinery equipment, and to the employee seeking knowledge beyond the scope of his present experience.



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HILTON HOTELS, Inc.
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Furnace Wall Construction.

By GEO. P. REINTJES☆

TO operate a boiler or still without a properly designed wall is about as economical as to operate an engine without piston rings. The object of the walls or of the rings is to keep the gases within the furnace, and the air out. Furnace walls have an added function—to reflect heat, assist combustion, and to radiate heat to the product to be heated. Before attempting to select the type of wall to be used on your furnace, you should have a thorough knowledge of the functioning of the furnace walls when subjected to heat, a complete knowledge of the product to be heated as well as the temperatures to be obtained, and lastly, the characteristics of the fuel burned.

Practically all furnace walls use refractories in one form or another. Most first class refractories will have a fusion point of between 3200 and 3300 degrees F. Carborundum brick of that class has a fusion point several hundred degrees higher.

When you consider that few boilers reach a furnace operating temperature of 2700 degrees and that the average temperature of an ordinary pipe still seldom averages 2000 degree F., it is readily seen that the failure of brickwork is due to causes other than excessive temperatures.

The primary cause of coal-fired boiler wall failure is erosion, caused by the mechanical blast action of the fly ash impinging against the wall, also a chemical reaction of the fluxes in the fuel and ash with the elements constituting the refractory. To remedy these conditions it is necessary to cool the brick to give it more strength to resist the blast action and to cool the bricks below the temperature at which the fusion will occur. There are many methods of cooling the walls, which will be discussed later.

Modern refinery still walls, except possibly the Dutch ovens, never fail from excessive temperature or fusion. What then is the cause of still wall failure? Lack of knowledge on the part of the erecting masons of the proper materials to select, the right methods of laying and bonding the bricks, including inadequate provision for expansion, as all refractories expand.

As shown by the curve accompanying this article, the amount of expansion does not increase proportionate to the increase of temperature. No two makes of refractory brick expand the same. Their expansion varies with the chemical constituents, the temperature at which the brick has been burned, the length of time the brick has been in service, the load upon the brick, and the porosity of the brick. Since the brick wall does not necessarily have its greatest expansion at its hottest face, the greatest expansion can occur within the wall closer to the cooler face. The actual temperature gradient of a particular furnace wall is seldom a straight line. The temperature drop cannot approximate a straight line until a sufficient period of time has elapsed to reach an equilibrium. The gradient is affected by the thickness of the wall, whether the furnace has a positive pressure or the reverse—a slight vacuum. The latter two would cause a leakage of hot gases, increasing the wall temperature, or the infiltration of air tending to cool the walls.

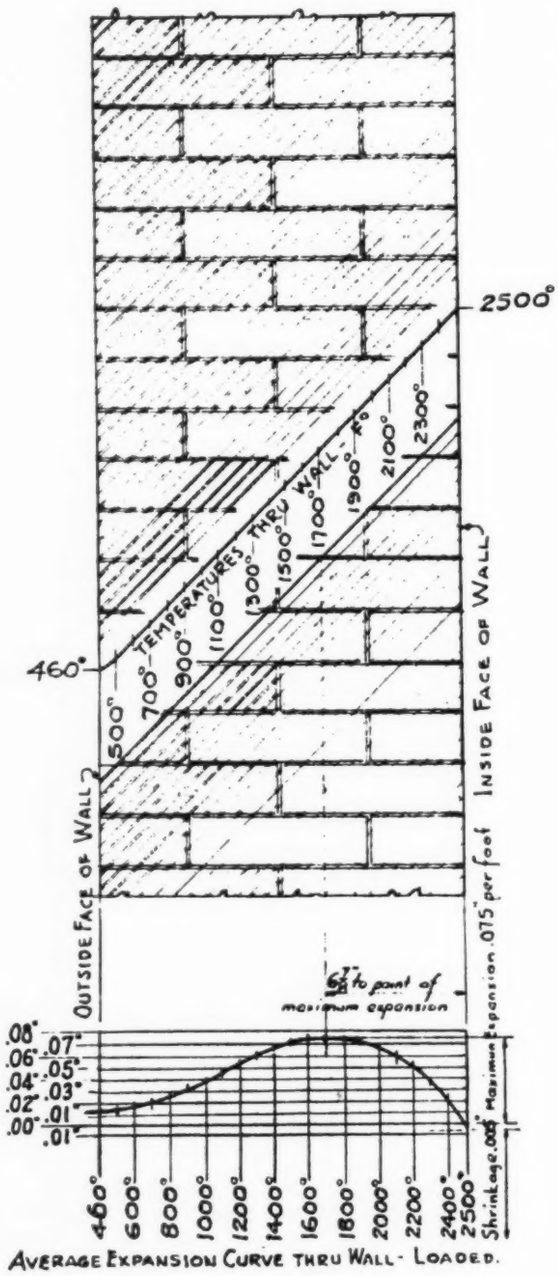

Figure 2

From the foregoing it may be concluded that there is no staple wall condition. The wall expansion is of a wrenching nature, tending to tear itself apart in all directions.

There is no set formula for overcoming this condition. A study must be made of each furnace.

One thing, however, is imperative. The wall must be flexible to avoid distortion. A thin board will bend, a thick board must have saw kerfs to avoid breaking.

There should be an expansion joint to every four feet in a wall laid up with high temperature cements to overcome the uneven increase in wall lengths due to the different amount of expansion within the walls.

An expansion joint should be placed at least every eight feet in a wall laid with fire clay. The bricks should be so laid that they can absorb some of the differential expansion between each brick rather than putting the bricks endwise.

Expansion joints bring on other problems. They must be packed with a material that will seal the joints, preventing air leakage and at the same time be compressible at all temperatures.

To date no material has been discovered or developed that will withstand furnace operating temperature. Due to the amount of cotton used to assist in weaving

☆ Geo. P. Reintjes Company.

Thermal Factors

asbestos rope, most commercial ropes are worthless when exposed to flame in a furnace. Asbestos fuses at about 900 degrees, rock wool will be brittle and crumble at the same temperature, and a slag wool will fail at 1400 to 1500 degrees F.

Radiant heat within the furnace reflects in all directions but it is most effective in penetrating the joints at right angles. The writer has never in his experience repaired a furnace where the packing in a rectangular joint had not entirely fused.

The angular joint shown in Figure 3 was developed to overcome as far as possible the conditions shown. It has proven its advantages in many boiler and still installations.

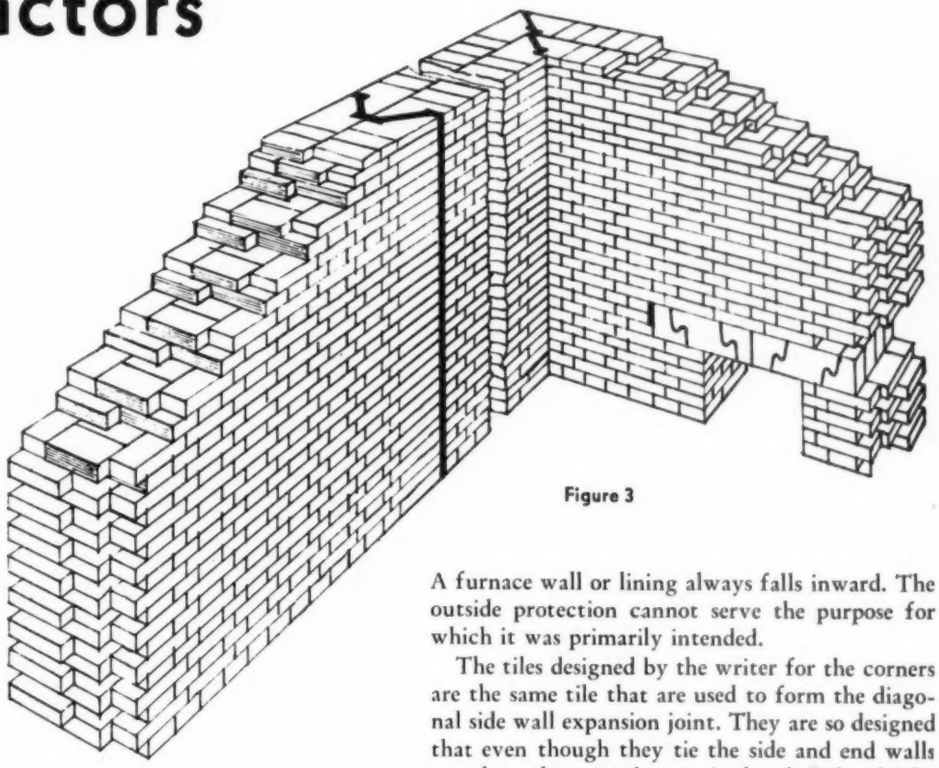

Figure 3

A boiler or still is subject to vibrations. In the earliest huts known, the corners were rigidly built and the angle used for strength against wind pressure. Many furnace walls, figuratively speaking, consist of four flat slabs upended with a few buck-stays on the outside to keep the walls from falling out. A furnace wall or lining always falls inward. The outside protection cannot serve the purpose for which it was primarily intended.

The tiles designed by the writer for the corners are the same tile that are used to form the diagonal side wall expansion joint. They are so designed that even though they tie the side and end walls together, they can be manipulated to break the bonds on each succeeding course and at the same time provide for some expansion in the angle.

As far as possible you should localize expansion, using more joints, and prevent the accumulation of expansion that tends to move the wall endwise.

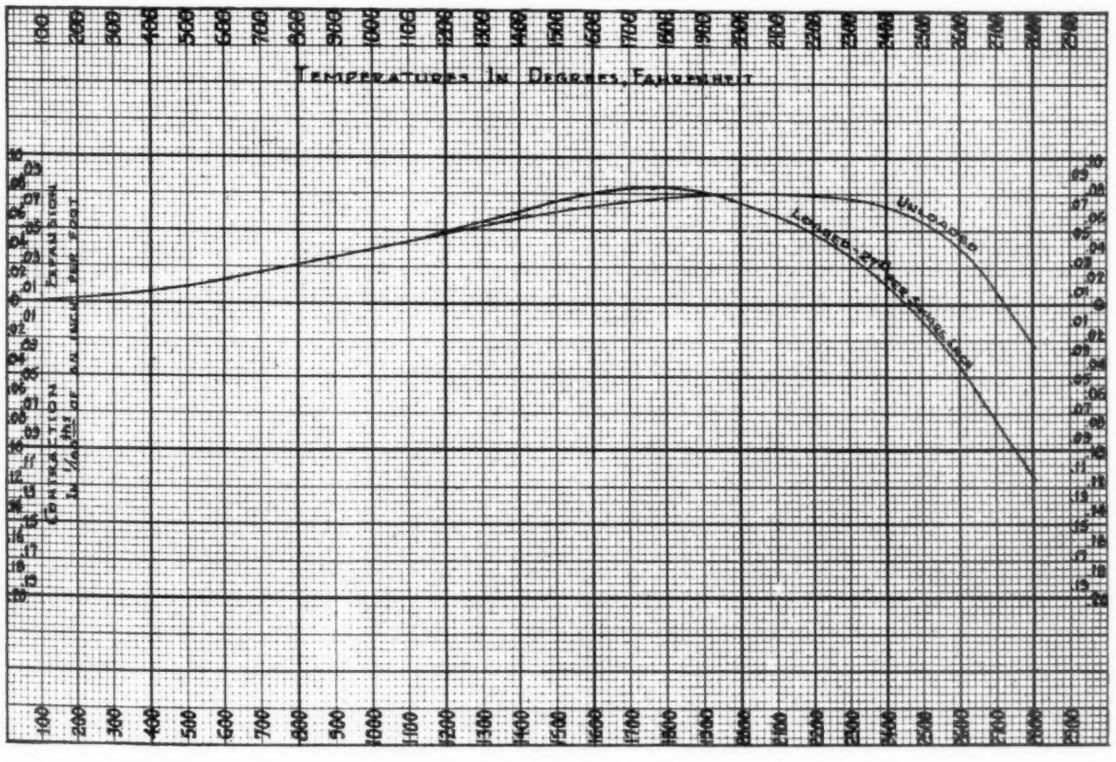

Figure 1

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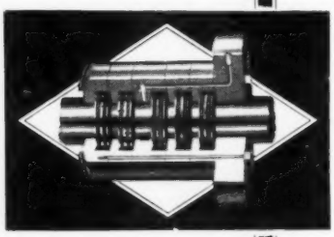

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High Pressure Welded Vessels Shipped to Quebec

What is believed to be the first shipment of high pressure welded vessels to the Province of Quebec was made recently, when two bubble towers and three separators were sent to the British-American Oil Company, Ltd., at Montreal by the refinery and gasoline plant division of Black, Sivalls & Bryson, Inc., located at Tulsa, Okla. The vessels were produced in the shop of the American Tank and Equipment Corporation at Oklahoma City, a subsidiary of the B. S. & B. Company.

Up to this time no welded pressure vessels of over 100 pounds per square inch working pressure (outside of the railway industry) had been permitted. In July of 1931, the Province of Quebec, by a special dispensation, allowed the British-American Oil Refineries to purchase these five vessels of welded construction. This was to be a test case.

The recovery tower, which was 60 feet tall, and three feet inside diameter, had 30 cast iron bubble trays, a shipping weight of 25,800 pounds and a working pressure of 300 pounds. It is used for extraction of gasoline from refinery gases. The stabilizer tower is being used to remove all light products from cracked gasoline.

Wichita, Kansas, Now Has A. P. I. Chapter

Wichita, Kansas, now has a local chapter of the A. P. I. Recently the oil and gas committee of the Wichita Chamber of Commerce appointed a committee to investigate and perfect the formation of a local A. P. I. chapter. This committee met and drafted a set of by-laws.

In addition to considering operating problems and to fostering a spirit of economic co-operation among those engaged directly in the production of oil and gas, and promoting a free interchange of ideas among members, special efforts will be directed to promoting a more cordial understanding by the general public of the close economic relationship that exists between the oil industry and other lines of business.

At a preliminary meeting the formation of an A. P. I. chapter was decided upon and a constitution and by-laws thereupon adopted.

The first meeting was held at the Allis Hotel, Wichita, at which 110 were present, and the following officers were elected: H. L. McQuiston, Phillips Petroleum Company, chairman; H. L. Williams, Mid-Continent Petroleum Corporation, first vice-chairman; N. M. Hutchinson, Empire Oil and Gas Company, El Dorado, second vice-chairman, and A. S. Ritchie, Derby Oil Company, secretary and treasurer.

Committee on Water Analysis

The purpose of the new Committee D-19 on Water Analysis of the A. S. T. M. is the study and preparation of methods of analysis of water; water being considered as an engineering material. In addition to standardization of methods the purpose includes terminology and interpretation of results of tests. It is proposed that the committee should first give consideration to the preparation of standard methods of analysis that would be of service in respect to corrosion tests. These tests will include the determination of carbon dioxide, dissolved oxygen, and hydrogen ion concentration.

Camp Company Appointed Distributors

C. F. Camp Company of Tulsa, Okla., has been appointed Oklahoma, Kansas and Texas Panhandle distributors for The McAlear Manufacturing Company of Chicago.

Fisher Governors Appoints Distributors

Fisher Governor Company, Marshalltown, Iowa, manufacturers of power plant specialties, has recently established two new exclusive representatives. One is the Grinnell Company of Minneapolis, Minn., and the other is the Steam Plant Equipment Company, Milwaukee, Wis.

Purchasing Material for Iraq Line

ORDERS have been placed by the Iraq Petroleum Company for 8,000 tons of 10¾-inch steel pipe with American Mills. This tonnage equals approximately 90 miles of pipe. Additional orders for approximately 980 miles of 12¾-inch pipe have been placed with European steel mills.

This line pipe will be used in the construction of the widely heralded Iraq project which consists of two separate lines. One will originate in Kirkuk and terminate at Tripoli in Syria and the other will start in Kirkuk and terminate at Haifa in Palestine. The Kirkuk-Tripoli line will be about 540 miles lone and the Kirkuk-Haifa line will be about 635 miles long. Both lines terminate at coastal points.

The combined capacity of the two carriers will be about 84,000 barrels daily against 800 pounds pressure and approximately 54,500 horse power engines will be required to drive the reciprocating pumps. Approximately 500,000 barrels of steel tankage will be purchased for the line.

The entire line is to be welded and all of the key positions for construction work have been filled. H. S. Austin, president of the Ajax Pipe Line Company, will be in charge of the work. He is to be assisted by M. Stuckey, formerly of the Andian National Corporation. C. A. Mulligan will be pipe line superintendent and will be assisted by George O'Connor and H. L. Hard. B. J. Davis, formerly with Humble Pipe Line Company, will be in charge of welding operations.

The Iraq Company is purchasing tractors and trucks and other construction equipment. About two and a half years' time is expected to be required to complete the project because of the difficulties which will be encountered in transporting material and supplies.

Babcock & Wilcox Granted Exclusive Rights In United States by Kimberly-Clark

THE BABCOCK & WILCOX COMPANY has been granted exclusive rights in the United States and Canada for the manufacture and sale of the automatic pressure circulating and indirect heating system of sulphite cooking, developed by the Kimberly-Clark Corporation.

This process, which is patented, is being successfully used in six digesters in the Kimberly Mill, Kimberly, Wis.

The manufacture of equipment for this process conforms with the policy of the Babcock & Wilcox Company of building special process equipment, such as welded pressure parts and corrosion-resisting alloy equipment, which comprise the important and vital parts of the Kimberly-Clark system.

Petroleum Equipment Company Has Kilgore Warehouse

JON R. LONG, of Petroleum Equipment Company, Fort Worth, Texas, has announced the establishment of a warehouse at Kilgore, Texas, to serve the East Texas oil fields. The new warehouse is under the supervision of Jess Emery, and will carry in addition to complete stocks of Petroleum Equipment Company products, a full line of Robinson Packer Company and Oil Field Engineering Company stocks.

Heavy Movement of Gas From Panhandle

A STATE investigator reports that natural gas transmission companies operating in the Texas Panhandle deliver more than 300,000,000 feet of gas daily for interstate pipe lines. The same investigator predicts the interstate carriers will be moving half a billion feet daily within a year.

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High Melting Point Grease Specifications

THE Material Division, Air Corps, Wright Field, recently issued United States Army Specification No. 3560-A for high melting point grease. They supersede specifications No. 3560, dated August 21, 1931.

I. General Specifications

1. The current issues of the following specifications in effect on date of issuance of proposals, form part of this specification:

2-22 boxes for oil and grease for export shipment.
100-2 standard specifications for making shipments.

2. The current issue of the Bureau of Mines Technical Paper No. 323—"Method of Testing Lubricants and Liquid Fuels" also forms a part of this specification.

II. Grades

1. This specification covers four grades of grease for the lubrication of hot running equipment, particularly electrical equipment. The grades shall be designated as follows:

No. 375—Soft
295—Soft, Medium
210—Hard, Medium
115—Hard

III. Material and Workmanship

1. This grease shall consist of a homogeneous mixture of petroleum oil and sodium soap or petroleum oil, sodium soap and calcium soap. It shall be free from all fillers, such as resin, waxes, or mineral matter, or any other material not naturally occurring in soaps or oils.

IV. General Requirements

1. The grease shall be a smooth, homogeneous mixture, free from crusts, lumps, or separated material.

2. Water—Method 300.12. The water content shall not exceed 1.0 per cent.

3. Insolubles—Method 541.2. The insolubles shall not exceed 0.2 per cent.

4. The grease shall pass the corrosion and stability test described in Section VI.

V. Detail Requirements

1. Penetration—Method 31.1. The penetration of the worked grease shall be within the following limits:

Grade	*Penetration*
375	350-400
295	270-320
210	185-235
115	90-140

2. Mineral Oil Content—Method 541.2. The mineral oil content shall not be less than as follows:

Grade	*Mineral Oil Per Cent*
375	84
295	77
210	69
115	60

3. Alkali and Acid Content—Method 541.2. Free acid calculated as oleic acid shall not exceed 0.10 per cent for all grades. Free alkali calculated as sodium hydroxide shall not exceed 0.10 per cent for Grades 375 and 295 and shall not exceed 0.20 per cent for Grades 210 and 115.

4. Properties of Mineral Oil Content—Method 541.2. The mineral oil content shall conform to the requirements specified in Table I.

Table I

Grade	Viscosity S.U.V. at 130 deg. F.	Pour Point (A.S.T.M.)	Specific Gravity 60 deg. F.	Color (A.S.T.M.)
		Maximum	Maximum	Maximum
375	120 to 160	15 deg. F.	.890	7
295	130 (Min.)			7
210	150 "			7
115	150 "			7

5. Melting Point.—The melting point determined as hereinafter described shall be not below 275 degrees F. for the

Grade 375 and not below 300 degrees F. for Grades 295, 210 and 115.

VI. Method of Inspection and Tests

1. Inspection shall be made at destination or at such place or places as may be specified by the contracting officer.

2. Sampling.—Samples shall be taken according to the procedure described in Part 5, Bureau of Mines Technical Paper No. 323. Whenever practicable, the inspector shall forward an original, unopened container to the proper laboratory for test.

3. As far as applicable all tests will be made according to the latest issue of Bureau of Mines Technical Paper No. 323 to which the method numbers given for the various requirements refer.

4. Melting Point.—Due to the absence of any standard method for the determination of melting point, the following tentative method shall be used: A thermometer of suitable range, graduated in intervals of two degrees F. shall be used. The bulb shall be three-fourths to one inch in length. A film of the thoroughly worked grease about one-sixteenth of an inch in thickness shall be applied as uniformly as possible to the thermometer bulb at room temperature. The thermometer shall then be suspended by a cork in a test tube about three-fourths of an inch in diameter with the bulb about one inch from the bottom of the tube. The test tube shall then be placed in an upright position in a suitable bath and the temperature raised at a rate of five to ten degrees F. per minute. A tall form 800 cc. beaker about two-thirds full of glycerin is a convenient bath. The temperature at which the grease melts and the first drop falls off the thermometer of the entire mass slides off the thermometer is recorded as the melting-point.

5. Corrosion and Stability Test.—An A.S.T.M. lubricating oil pour test tube of a similar container shall be filled with the grease and a clean, bright, mechanically polished copper strip immersed therein. The tube shall then be placed in an air oven at 95 to 100 degrees C. (203 to 212 degrees F.) for five hours, after which it shall be allowed to cool to room temperature. The grease shall show no crusts, lumps, or separated material and shall be of typical greasy texture and consistency similar to its original condition. There shall be no green coloration of the grease nor the copper strip and no brown nor black stain on the copper.

VII. Notes

1. The type of grease described by this specification is sometimes commercially designated as "Fibre Grease."

2. This grease is intended for use in engines accessory equipment operating at high temperature.

3. In general the various grades should be used as follows: Grades Nos. 375 and 295 for ball-bearings; Grades Nos. 295 and 210 for plain bearings; Grade No. 295 for gears; Grade No. 375 for saturating lubricating wastes or washers. Grade No. 115 is to be used when a high degree of lubrication is not required and it is essential that the grease stay in place for long periods of time. Grade No. 375 is also intended for use in equipment which must operate at low temperature.

4. Notice: When government drawings, specifications, or other data are used for any purpose other than in connection with a definitely related government procurement operation, the United States government thereby incurs no responsibility nor any obligation whatsoever; and the fact that the government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use, or sell any patented invention that may in any way be related thereto.

5. The use of this specification, whenever applicable, is mandatory on all procuring agencies of the army.

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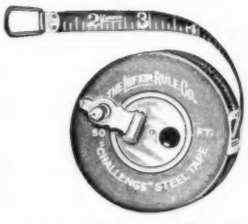

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Evaporation System Solves Gulf Coast Boiler Water Problem

By J. M. TOTTEN☆

A Bird's-eye View of Operations at Lake Barre, La., taken from the top of one of the rigs

THE urgent problem of securing suitable boiler water for drilling purposes in the Lake Barre, La., field has been solved by the installation of evaporators that produce a distillate from the lake salt water. The resulting product has been used quite satisfactorily in the drilling of several wells in the district.

The field, located along the Gulf Coast in the southern fringe of Louisiana, is situated entirely in marine waters. Despite this abundance of water, none of it is suitable for boiler use, a condition that has caused considerable expense and trouble in the region. A similar condition is very often encountered in the other fields lying amid the great number of small islands that dot the horizon of many lakes, bays and bayous, which divide this part of the state into a great patchwork of land and water.

The water in this lake is quite brackish, and is therefore entirely unsuitable for use in steam boilers, as the salts contained in it would deposit scale coatings in them and cause over-heating of the boiler metal. Several water wells have been drilled, but the water so obtained is little better than the lake water. For a time, fresh water was brought from a long distance in barges, but this procedure was accompanied by many disadvantages. The cost of transportation proved high, and frequently salt water leaked into the barges, polluting the fresh water. Stormy weather, also, prevented delivery of the water at scheduled times and occasionally caused costly delays in drilling operations.

Apparently, the only remaining solution was to distill the lake water in evaporators. This was a very logical answer to the problem, because for many years evaporators have been used on shipboard to produce good boiler water from sea water. An evaporator is essentially a special form of boiler in which water is evaporated by steam heat instead of heat derived from the burning of fuel. These evaporators remove all the salt and other scale-forming impurities from the lake water. The resulting product is an ideal water for steam boilers.

The evaporator plant, as used here, is essentially a two-effect one, consisting of two duplicate Griscom-Russell evaporators, together with the necessary auxiliaries, which include a G-R bentube section, that acts as an atmospheric type vapor condenser. A sketch accompanying this article clearly shows the working order of this plant.

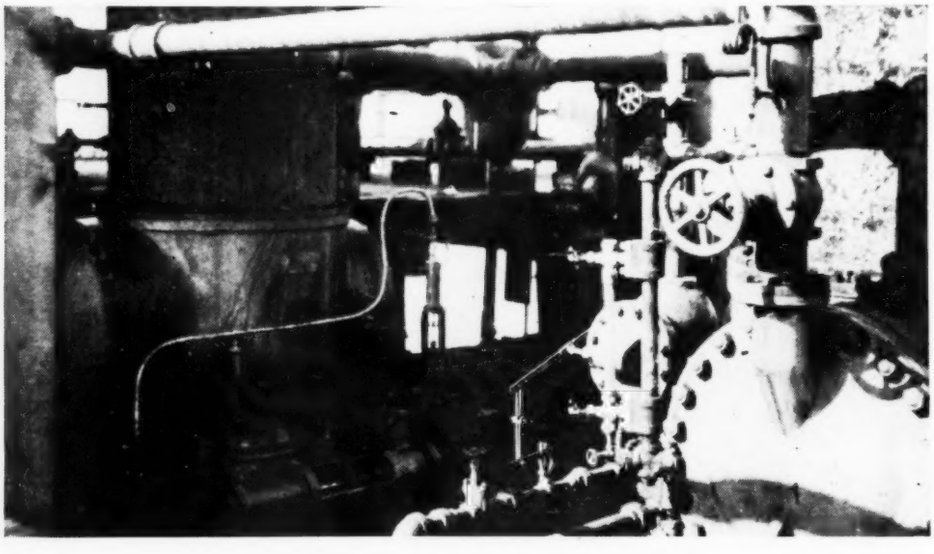
Boiler steam of 150 pounds pressure is throttled to 70 pounds gauge at the inlet to the first-effect evaporator, where vapor at 27 pounds gauge is generated. This vapor is conducted to the tubes of the second-effect evaporator, in the shell of which is generated vapor at two pounds gauge pressure. The condensate from the evaporator tubes in both the first-effect and second-effect evaporators is trapped through a Corliss valve steam trap to a receiver tank.

The vapor from the second-effect shell, along with the auxiliary exhaust steam passes through a steam separator and thence into the tubes of an atmospheric type surface condenser, over which the lake water is sprayed.

The condensate gravitates from the condenser to the receiver tank, out of which it is pumped to the fresh water storage. The storage tank, being centrally located, can supply distilled boiler feed wherever required. A flash line from the receiver tank allows flash from the evaporator drains to pass to the condenser inlet.

Float controlled G-R auto-

☆ Griscom-Russell Company, Dallas, Texas.



Evaporators and Automatic Feeder. Evaporator Feed Pump in center foreground

matic feeders maintain a constant water level in the evaporator shells, while the Corliss valve steam traps keep the evaporator tubes drained continuously. These devices make the plant almost automatic, only one unskilled attendant being required. Spring loaded consolidated safety valves protect the evaporator shells from excessive pressures. Large bottom blowdown valves are used to empty the shells of water and dislodged scale. A small amount of blowdown is continuously drawn off through one-inch valves on the shells.

A three-inch independent evaporator feed connection is supplied, through which the evaporator shells can be quickly filled when thermally cracking accumulated scale. A salinometer pot enables density determinations to be made of water in the shells. The condenser is supplied with circulating water by a single-stage turbine-driven centrifugal pump, taking its suction directly from the lake and discharging through nozzles above the condenser. The duplex steam pump handling distillate is governed by the level in the receiver tank, being equipped with a steam valve that is operated by a float mechanism.

The evaporators are unique in that the evaporating surface is scale shedding. When it is desired to crack off accumulated scale, the tubes are caused to expand and contract suddenly by intermittent application of cold water to the outside and steam to the inside of the tubes. The tubes have a slight initial curvature, and as they expand this initial curvature is increased, causing the scale to flake off the tubes in a manner similar to the shedding of bark by a sycamore tree. Under the conditions encountered here, it is a good practice to crack off the scale approximately every eight hours. The surface condenser is also of the scale-shedding design and removal of the scale deposit is accomplished in a manner similar to that employed on the evaporators.

This plant possesses many advantages. All of the component parts are of such size as to be readily transported from one location to another; the temporary nature of wildcat operations making this a vital requirement. It is possible to operate the two evaporators in parallel as single-effect units if a greater amount of distillate is required. The distillate produced is an ideal boiler feed and eliminates costly delays for the repair and cleaning of boilers and greatly prolongs the life of the steam boilers.

This general district is quite picturesque and fascinating, because of its vast marshy lands and waterways. All travel, including transportation of materials, is accomplished by means of boats. Montegut, about sixty miles south of New Orleans, is really the last outpost of civilization, although it boasts of only a general store and post office. The land on which it is situated has at times been under four feet of water, brought in by terrific storms from the Gulf.

Here The Texas Company has its warehouse and storage yards for the district. The warehouse is the general headquarters of this division of the production company, and in it are the offices of the division superintendent and his clerical force. The storage yard contains all manner of oil well supplies, drill bits, drill pipe, valves, blowout preventers and other essential pieces of oil field equipment. A fleet of six fast power boats makes this point the base of their operations, and a shop is equipped to maintain these boats in first class condition. Another activity at this warehouse is the preparation of drilling mud and its distribution to the various rigs.

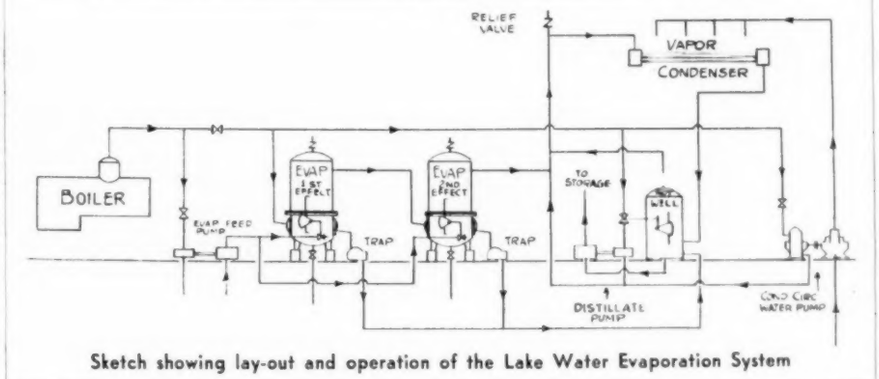
Each season of the year has its particular pest with which to contend. In the early spring the bothersome deer fly puts in his appearance. A little later comes the sheriff fly, which feeds upon the deer fly. During the summer months hordes of mosquitoes besiege the workmen on the drilling rigs. Gnats are almost always in evidence. A weird contraption is used to combat these pests. A small engine, usually an old model Ford motor, is mounted on a stand, but in place of having a flywheel a two-bladed propeller is substituted. These fans are mounted on the derrick floor and the blast of air is directed on the workers. This is an effective means of driving away the mosquitoes and other pests, and without these fans work would be virtually impossible.

The oil fields of the region are literally mounted on stilts, all of the steel oil well derricks, boiler houses and tanks being mounted on heavy piling under-timbers. These various necessary structures are connected together with narrow plank "catwalks," which also carry pipe lines, gas lines and necessary flow lines. When wells are completed the steel derricks are removed, leaving only the platform and Christmas tree connections to make the location of producing wells.

At Lake Barre, like in most of the other marine fields of Southern Louisiana, large tanks are provided for the storage of produced oil. Barges, capable of holding about 12,000 barrels of crude oil each, are used to transport the oil away. The barges are towed by sturdy sea-going tugs to the Gulf, whence the oil is delivered to waiting tankers that carry it to various refineries along the Gulf Coast.

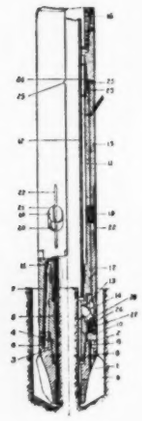
The above account of the way the oil companies have met drilling conditions is but one of the many interesting applications of modern engineering and equipment in this unusual area. At Leesville, which may be reached by boat from Lake Barre through the maze of confused bayous and lakes, The Texas Company has a very unusual electrical installation. A complete power plant, consisting of two duplicate oil engine-driven generators, is located on a barge that is known as the "Energy" barge. The barge is tied up near the drilling derrick and supplies all the power for conducting the drilling operations. The equipment and operation of this floating electric power plant was fully described in *The Petroleum Engineer* for May, 1931, in the article "Design and Operation of an A. C. Diesel Electric Rig," by H. F. Shepherd.

The writer is gratefully indebted to L. K. Laney, consulting engineer of The Texas Company, for his kind assistance and the use of photographs.



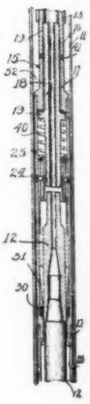
Sketch showing lay-out and operation of the Lake Water Evaporation System

NEW PATENTS OF THE INDUSTRY



1,858,248. CORE CATCHING DEVICE. FLOYD L. SCOTT and HENRY T. BAGGETT, Houston, Tex., assignors to Hughes Tool Company, Houston, Tex., a Corporation of Texas. Filed Aug. 19, 1930. Serial No. 476,300. 4 Claims. (Cl. 255—72.)

1. A core drill including a drill collar, a drill bit thereon, said drill collar having an upwardly extending sleeve thereon, a drive sleeve telescoping over said drill collar, an interior packing sleeve at the upper end of said drill collar, a vent connected with the outer side of said packing sleeve, and core-engaging means actuated by the relative movement of said collar and drive sleeve.

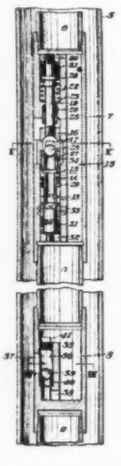


1,858,500. METHOD OF AND ROTARY SOCKET FOR FISHING OBJECTS FROM WELLS. FRANK J. HINDERLITER, Tulsa, Okla. Filed March 21, 1929. Serial No. 348,695. 24 Claims. (Cl. 294—102.)

1. The method of removing an object from a well with a given tool which consists in lowering the tool in the well to a position adjacent said object, forming a seal in said well at said position, removing liquid from above said position to enable the hydraulic pressure in the bottom of said well to force said object free from the bottom of the well, and then raising said object from the well.

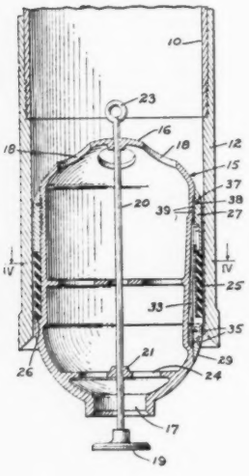
1,857,634. METHOD OF AND APPARATUS FOR AUTOMATICALLY RAISING LIQUIDS FROM WELLS. EDGAR E. GREVE, Bellevue, Pa., assignor, by mesne assignments, to Oil Well Supply Company, Pittsburgh, Pa., a Corporation of New Jersey. Filed Dec. 17, 1927. Serial No. 240,806. 13 Claims. (Cl. 103—233.)

1. An apparatus for elevating liquids from a well including an actuating fluid pressure pipe having outlet openings arranged at different vertical levels therein, automatically operable balanced piston valves for controlling the discharge of actuating fluid from said pipe, said valves being actuated by the height of the column of the liquid in the well, and means for preventing the liquid being raised from entering the pressure fluid supply pipe.



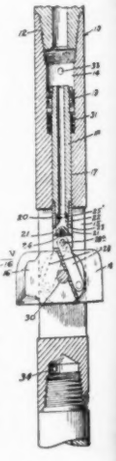
1,858,501. APPARATUS FOR CEMENTING WELL CASINGS. FRANK J. HINDERLITER, Tulsa, Okla. Filed Sept. 25, 1929. Serial No. 394,951. 3 Claims. (Cl. 166—19.)

1. In a device for depositing a sealing material in a well, a hollow member having a discharge opening, a sleeve on said member having an opening for registration with said discharge opening, a rod mounted on said sleeve, said elements being axially movable relative to each other, a drag shoe carried by said rod for engagement with the wall of the well, a latch for securing said rod and sleeve against relative movement upon the upward pull of said member, means effecting a registration of the openings by lowering said member after the rod and sleeve have been secured together, and a detent for latching the member and sleeve against relative movement when the openings are in registration.



1,858,215. CEMENTING PLUG. REUBEN C. BAKER, Coalinga, Calif., assignor to Baker Oil Tools, Inc., Huntington Park, Calif., a Corporation of California. Filed Nov. 19, 1929. Serial No. 408,311. 3 Claims. (Cl. 166—13.)

1. A device of the character described comprising a body adapted to be lowered through a string of well casing, a normally contracted expansible member carried by the body, means engageable with the lower edge of the casing to secure the body in its lowered position, said means acting to expand the expansible member against the inner surface of the casing whereby the lower end of said casing will be sealed.

1,857,616. HYDRAULIC UNDERREAMER. REUBEN BAKER, Coalinga, Calif., assignor to Baker Oil Tools, Inc., Huntington Park, Calif., a Corporation of California. Filed Feb. 3, 1931. Serial No. 513,135. 6 Claims. (Cl. 255—76.)

1. A tool of the character described comprising a barrel adapted to be connected at its upper end with a drill stem, a pilot bit connected to the lower end of the barrel, said pilot bit having a central passageway formed downwardly through its upper end and emerging adjacent the point of the bit, said barrel being formed with longitudinal passageways contiguous to its periphery extending from the upper end of the barrel to a point adjacent the lower end thereof and in communication with the pilot bit passageway at the lower end of the barrel, the upper end of said passageways communicating with the interior of the barrel at a point adjacent the upper end of the barrel whereby circulating fluid from the drill stem will pass through said passageways and lubricate said bit, and reaming means carried by the barrel and positioned intermediate the ends thereof.